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(12) **United States Patent**
Whitman

(10) **Patent No.: US 8,888,762 B2**
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(54) **FLEXIBLE SHAFT EXTENDER AND METHOD OF USING SAME**

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(73) Assignee: **Covidien LP**, Mansfield, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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(51) **Int. Cl.**
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A61B 17/068 (2006.01)

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CPC ***A61B 17/068*** (2013.01); ***A61B 17/1626*** (2013.01); ***A61B 17/1631*** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC A61B 17/1631; A61B 7/32002; A61B 2017/068; A61B 2017/00477; A61B 2017/23032
USPC 606/1; 227/178.1, 180.1
See application file for complete search history.

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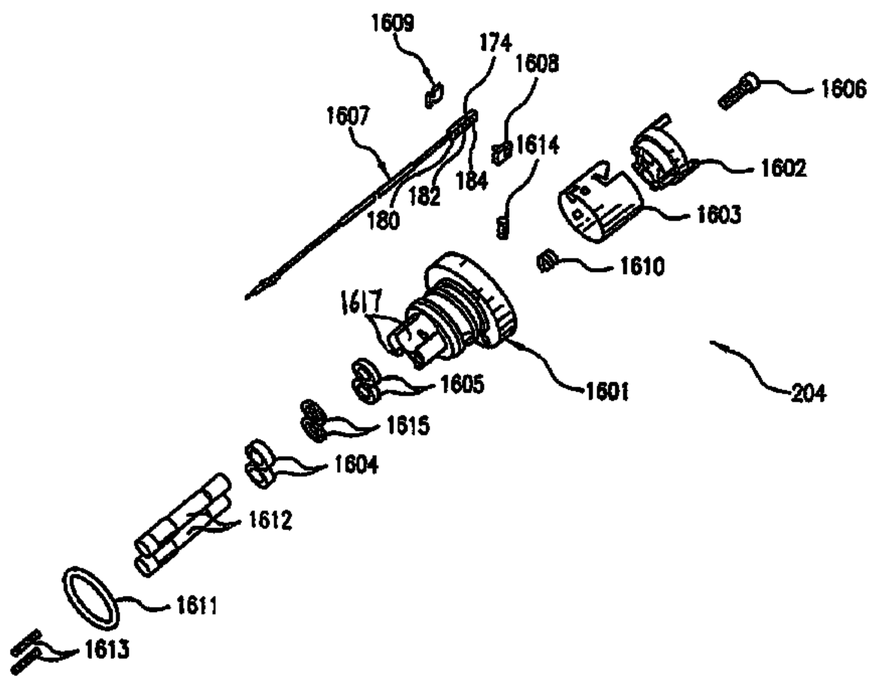
(57) **ABSTRACT**

An extender for use in an electro-mechanical surgical system that includes a surgical attachment that may be detachably coupled to an electro-mechanical driver device via a flexible shaft. The extender is a substantially rigid extender that includes a proximal end that may be detachably coupled to a distal end of the flexible shaft. The extender also includes a distal end that may be detachably coupled to the surgical attachment. The extender also includes at least one rotatable drive shaft configured to engage and be secured with a respective rotatable drive shaft of the flexible shaft such that rotation of the respective rotatable drive shaft of the flexible shaft by the electro-mechanical driver device causes the at least one rotatable drive shaft of the extender to rotate, thereby rotating a complementary connector of the surgical attachment so as to operate the surgical attachment. The extender may include a memory unit and a data cable that transfers data from the memory unit to an electro-mechanical driver device. Additionally or alternatively, the extender may include a data cable that transfers data from a memory unit in the surgical attachment to the electro-mechanical driver device. Advantageously, the extender is autoclavable.

17 Claims, 22 Drawing Sheets



Related U.S. Application Data

continuation of application No. 11/194,950, filed on Aug. 1, 2005, now Pat. No. 7,947,034.

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(51) **Int. Cl.**

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A61B 17/04	(2006.01)
A61B 17/10	(2006.01)
A61B 17/16	(2006.01)
A61B 17/00	(2006.01)
A61B 19/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 17/32002*** (2013.01); *A61B 2017/003* (2013.01); *A61B 2017/00482* (2013.01); *A61B 2017/320032* (2013.01); *A61B 2019/4815* (2013.01)

USPC **606/1**; 227/178.1; 227/180.1

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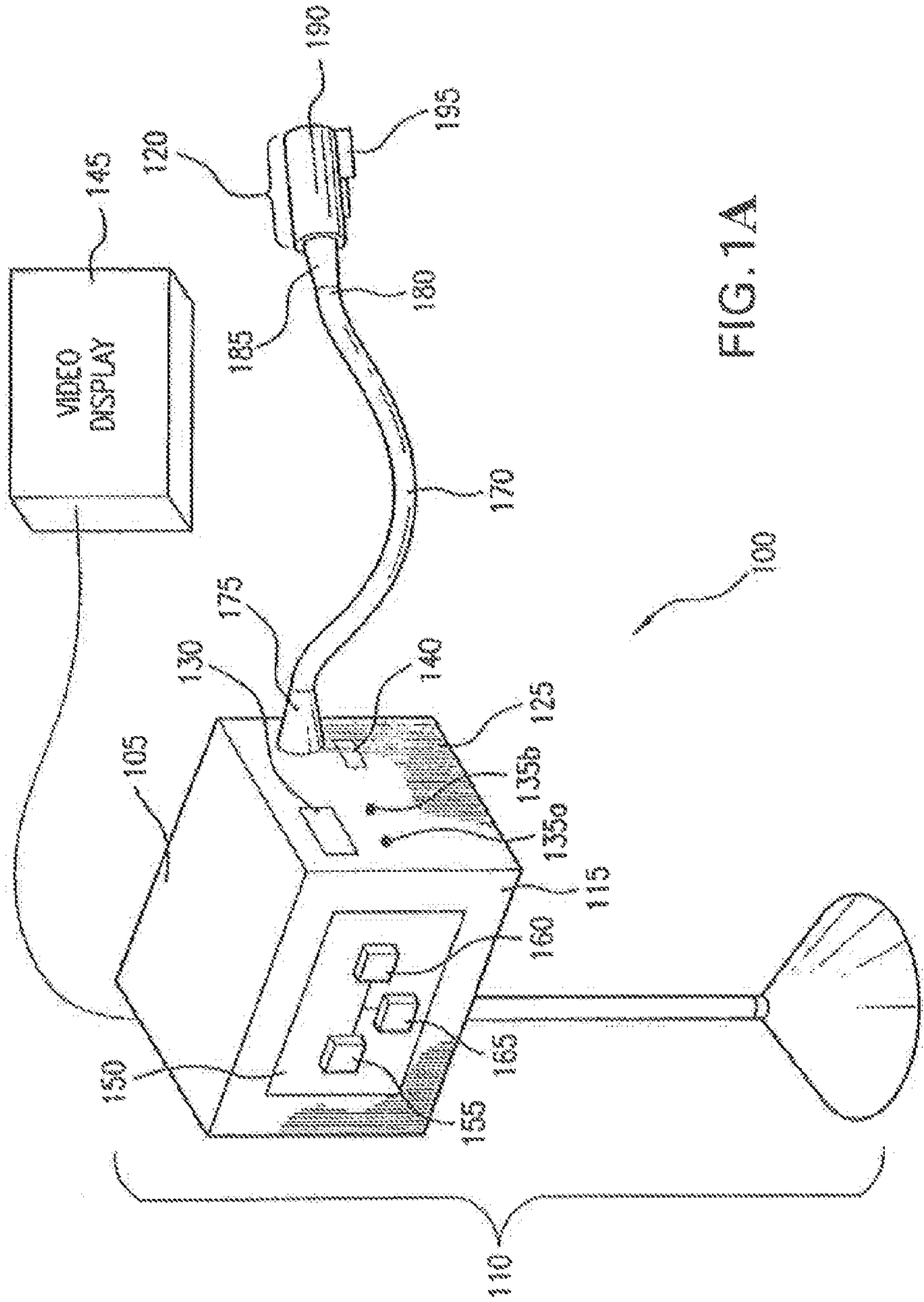
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FIG. 1A

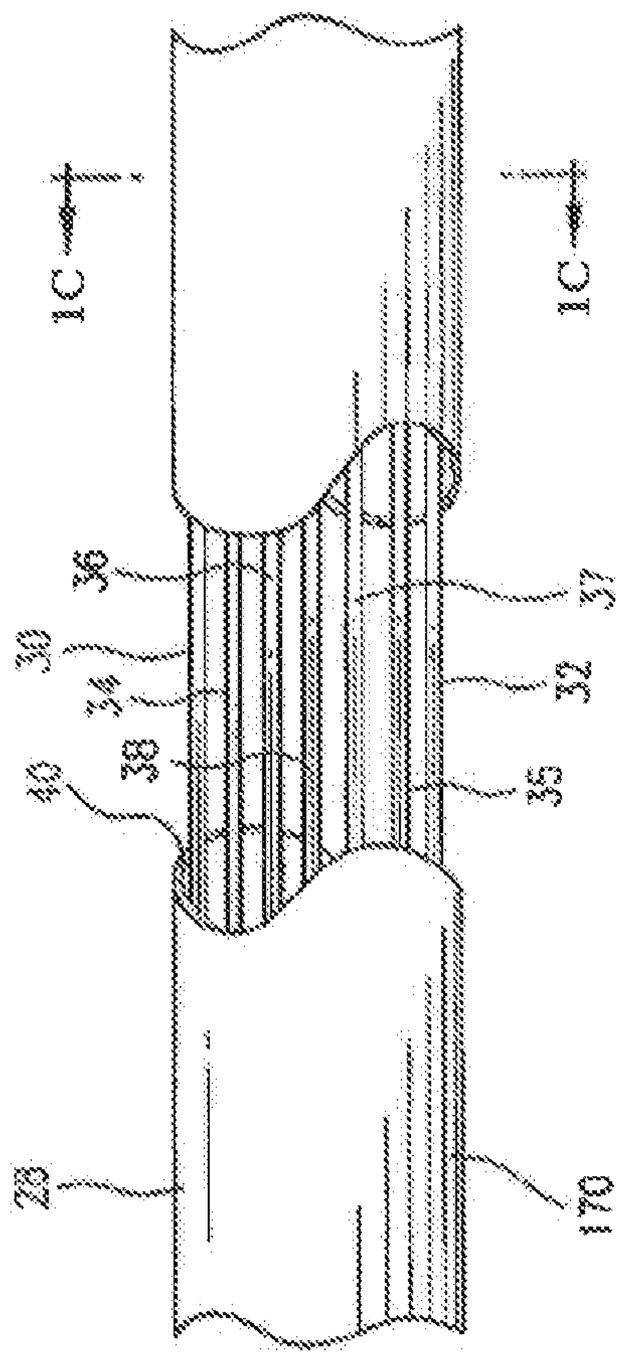

FIG. 1B

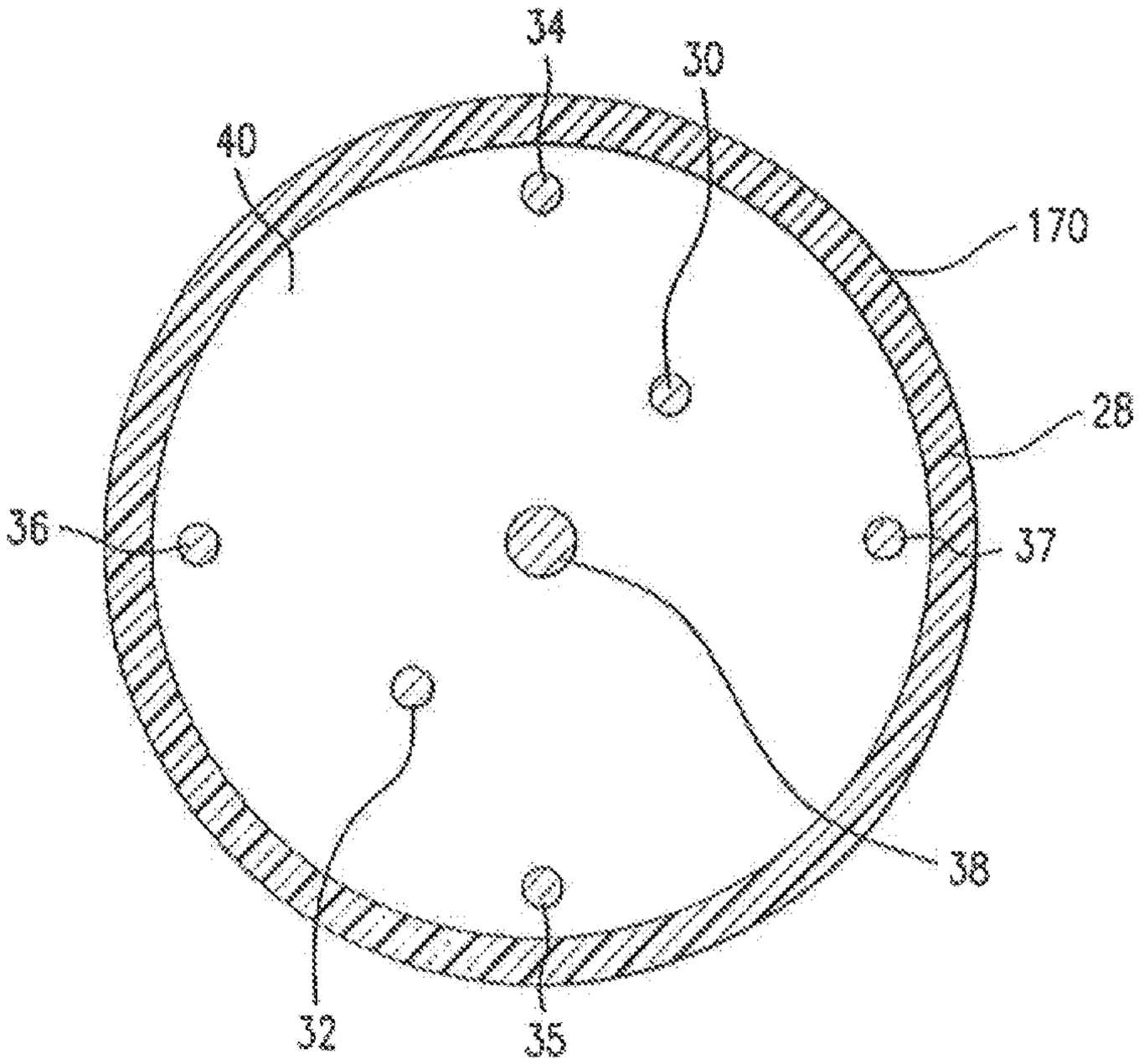

FIG. 1C

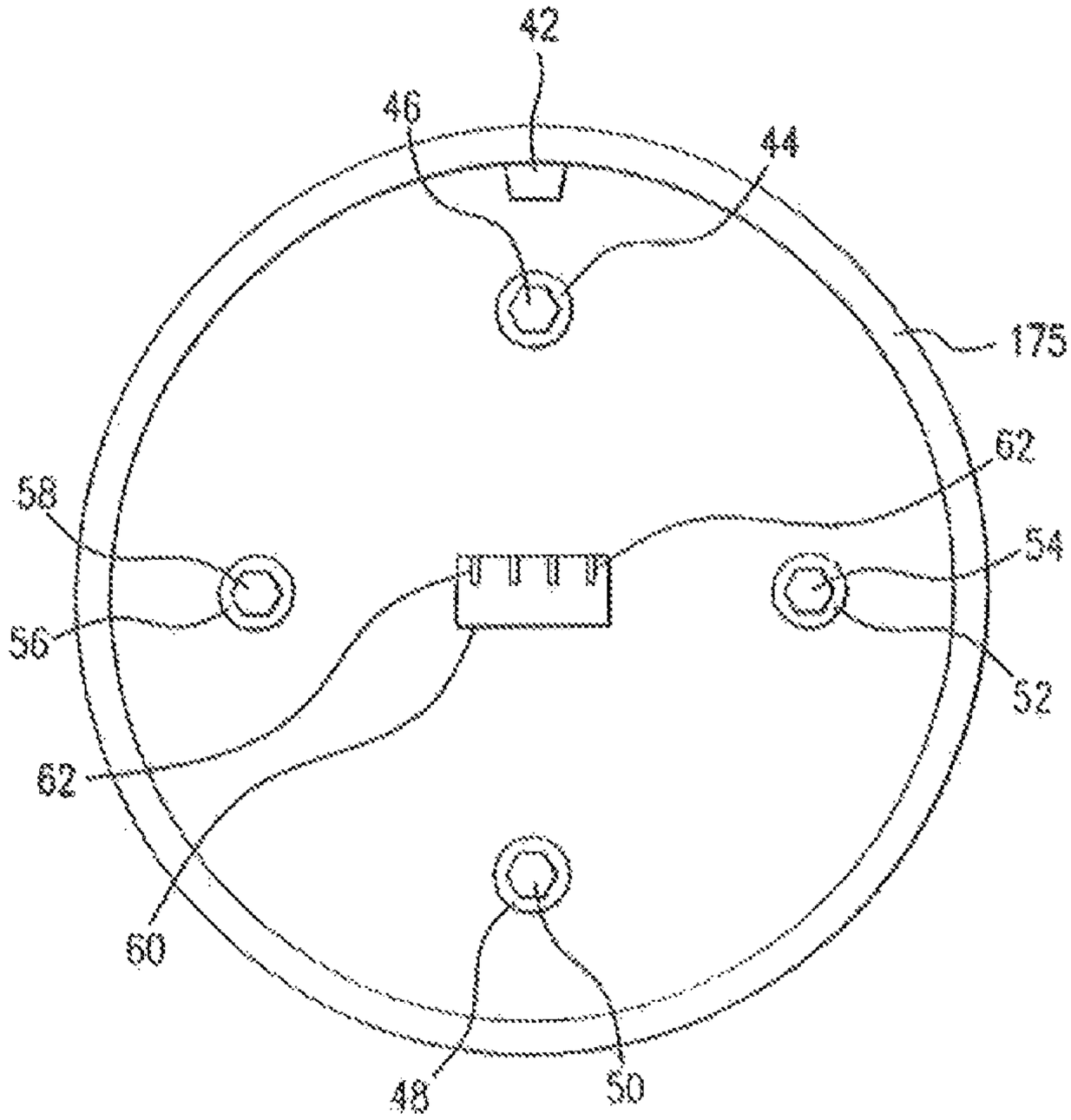

FIG. 1D

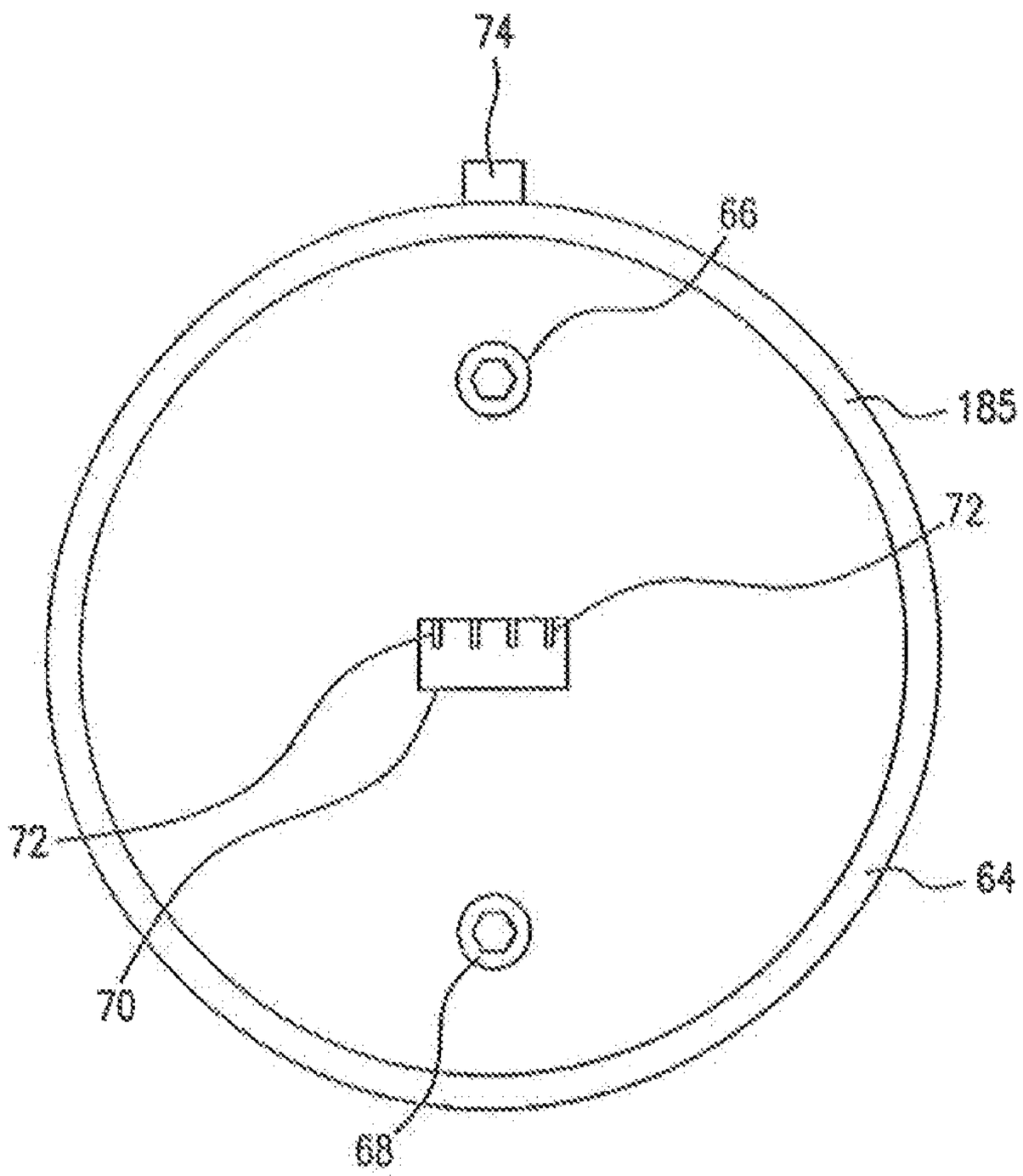

FIG. 1E

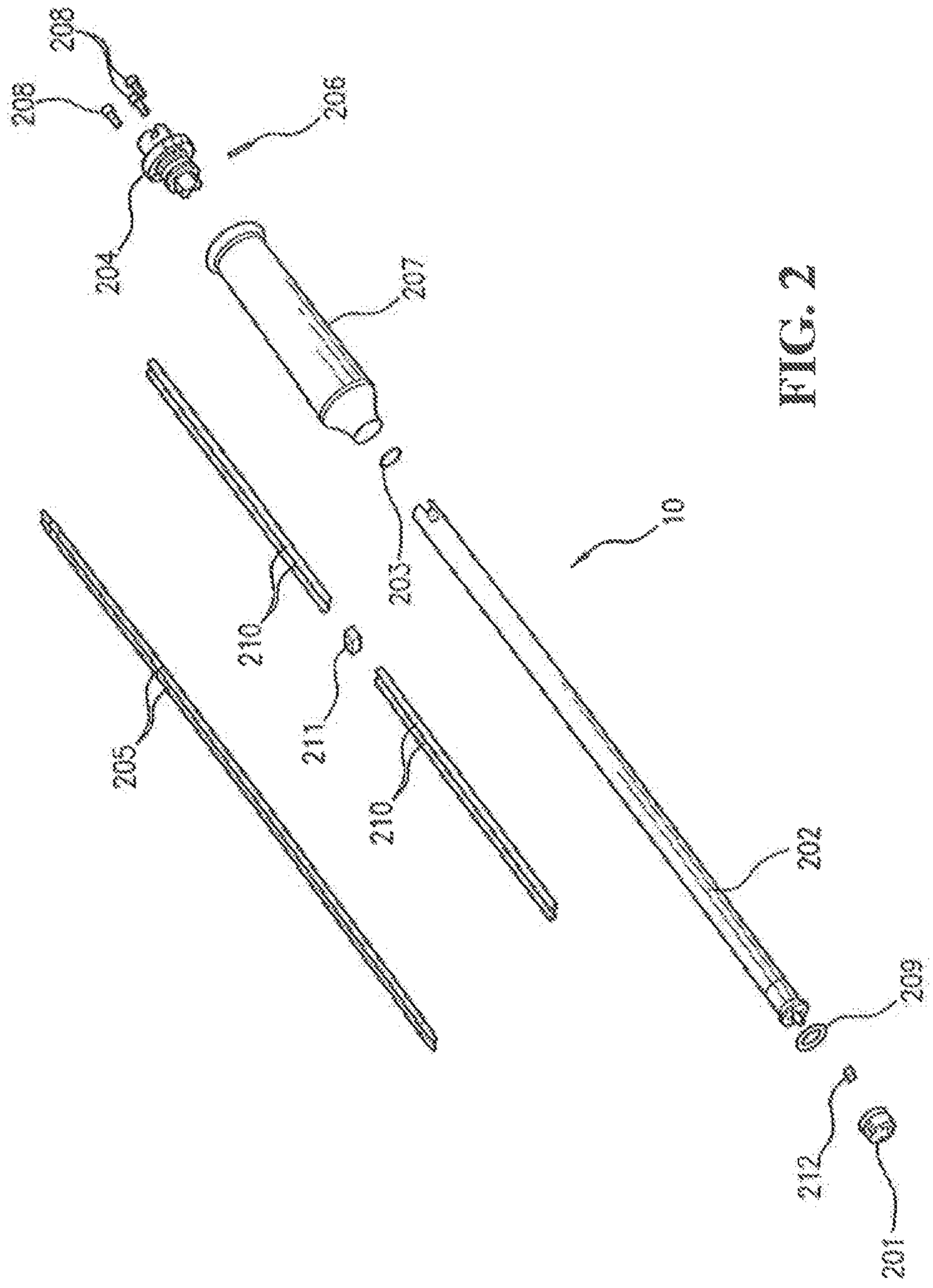

FIG. 2

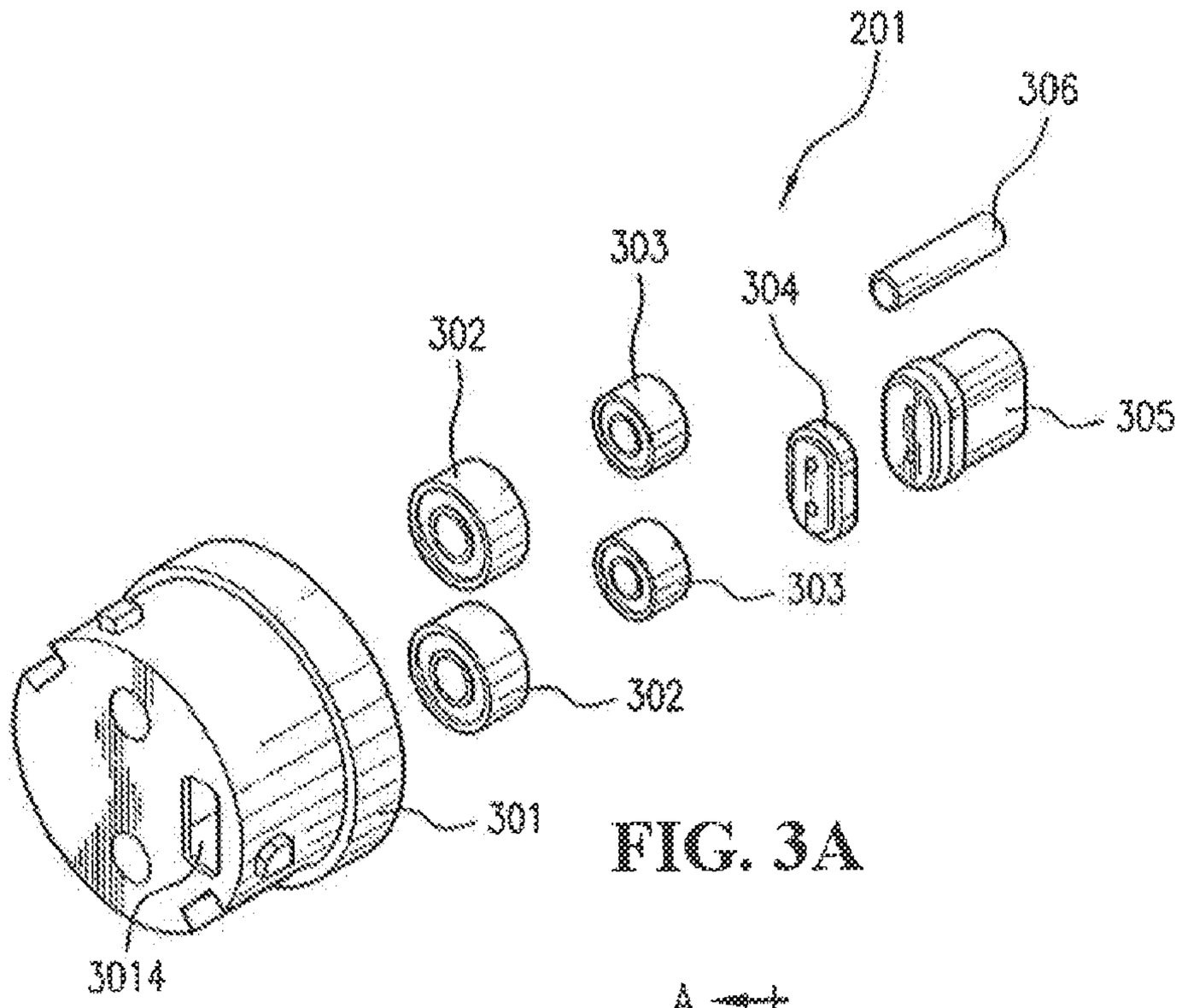

FIG. 3A

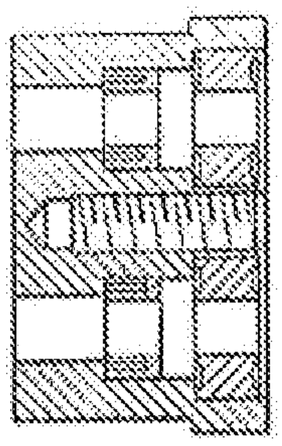

FIG. 3B

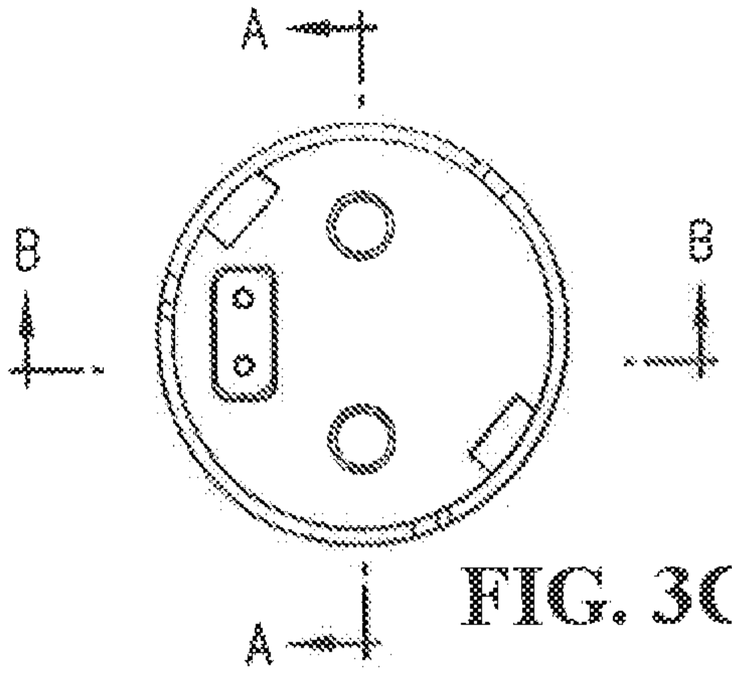

FIG. 3C

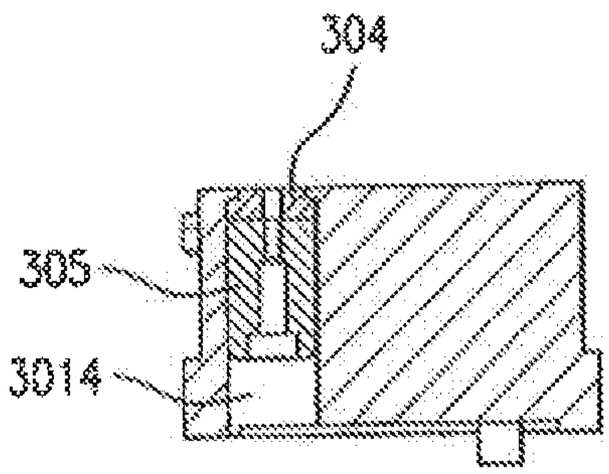

FIG. 3D

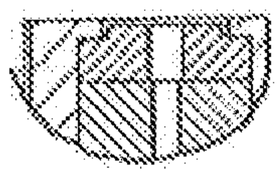

FIG. 3E

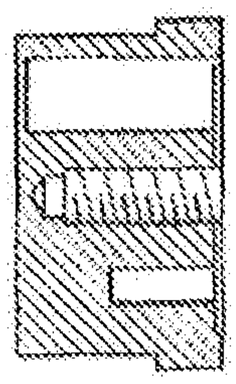

FIG. 4B

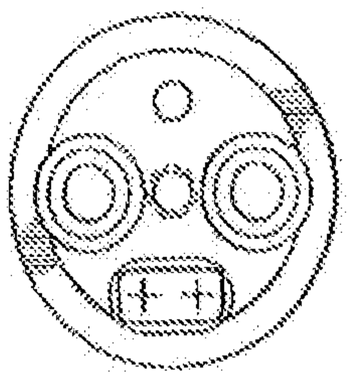

FIG. 4D

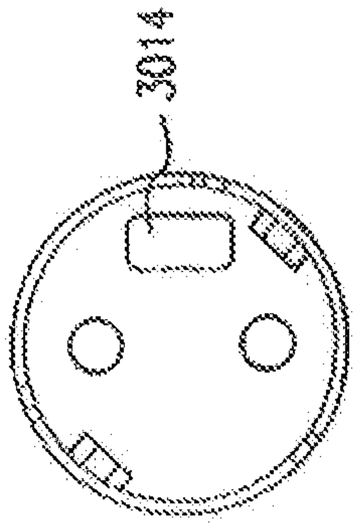

FIG. 4A

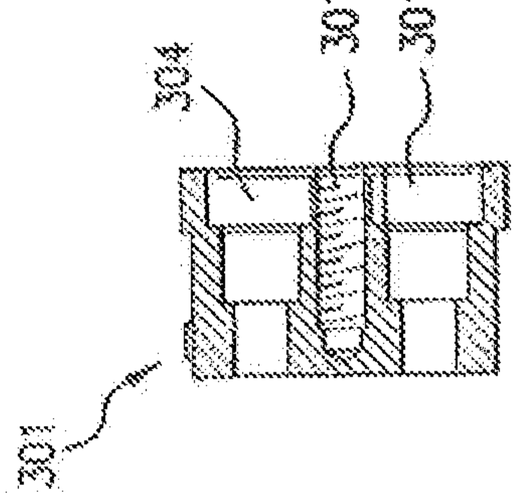

FIG. 4C

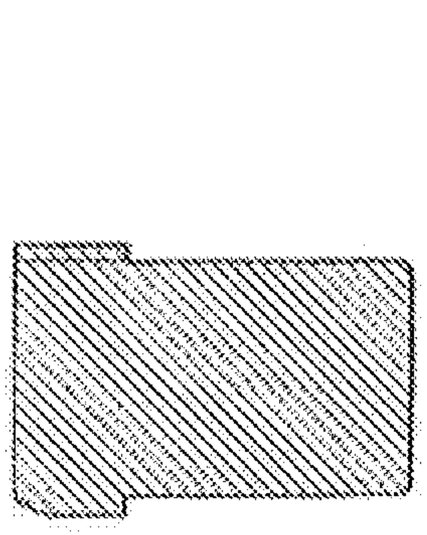

FIG. 5A

FIG. 5B

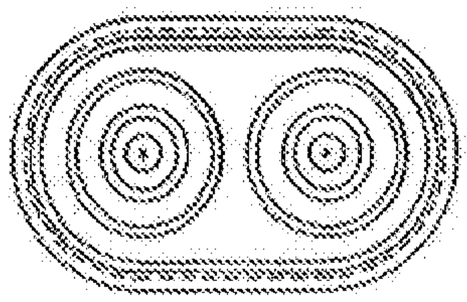

FIG. 5E

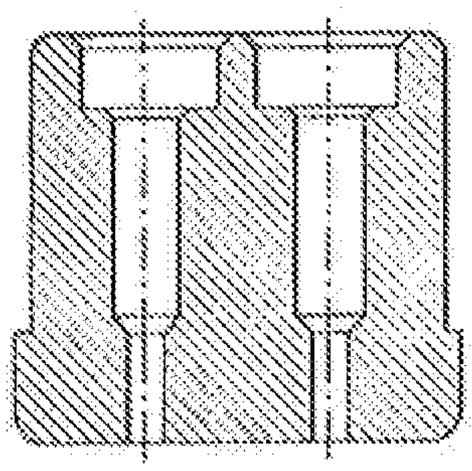

FIG. 5D

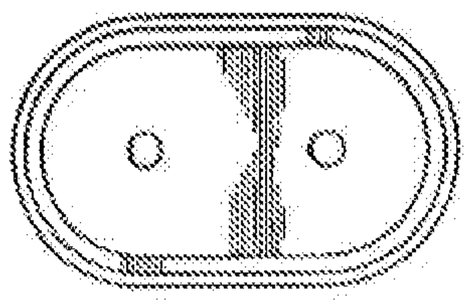

FIG. 5C

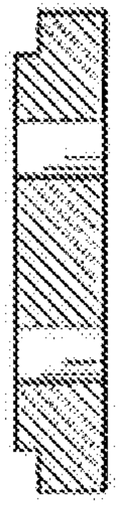

FIG. 6B

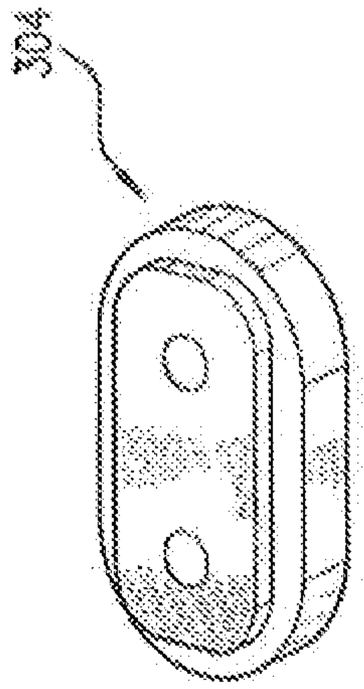

FIG. 6C

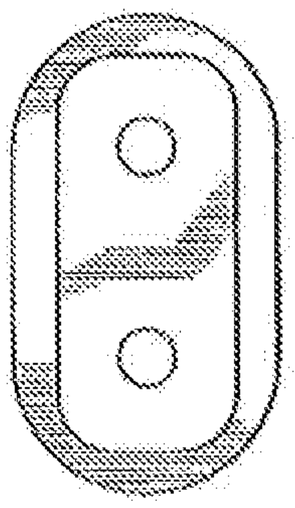

FIG. 6A

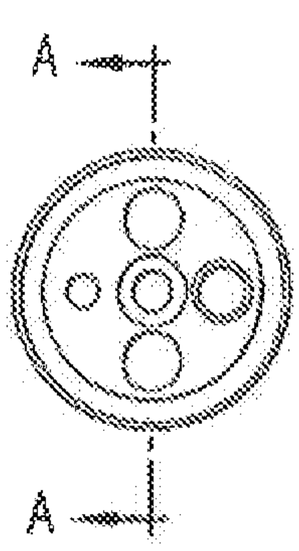

FIG. 7A

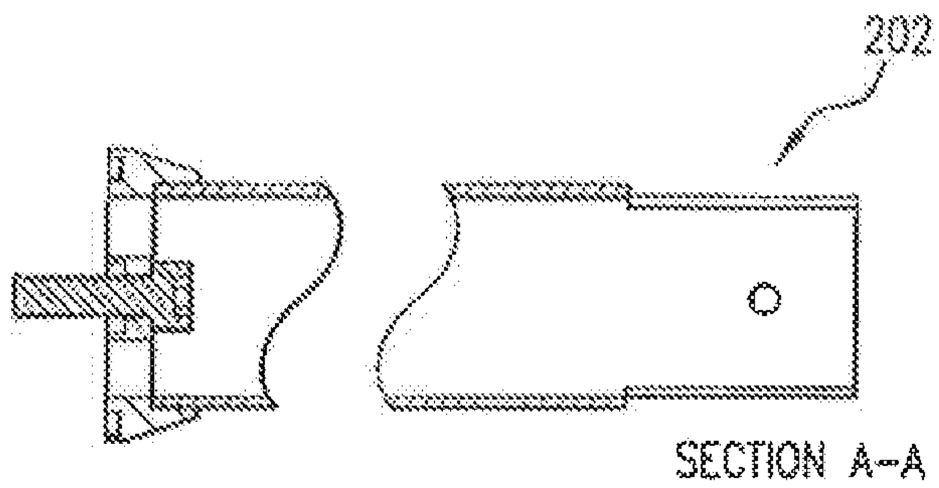

FIG. 7B

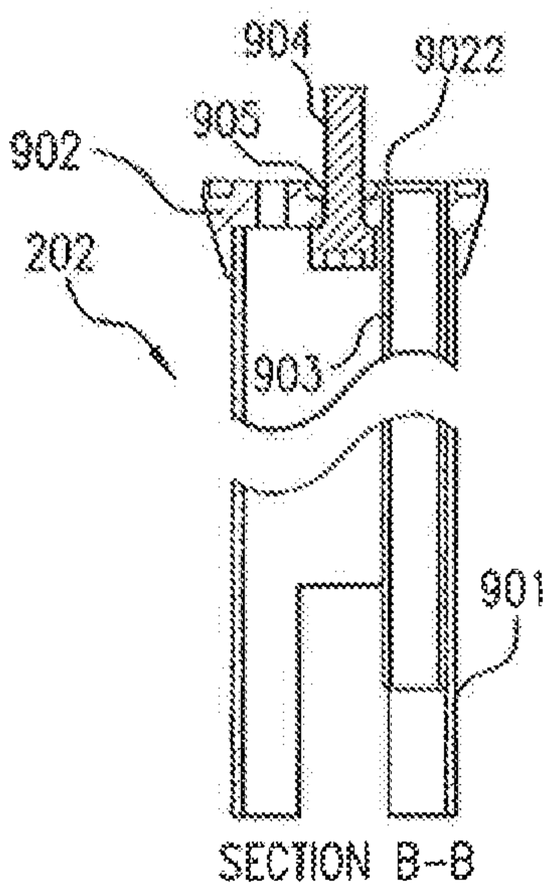

FIG. 7D

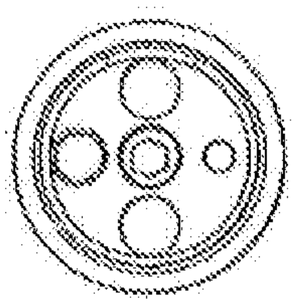

FIG. 7C

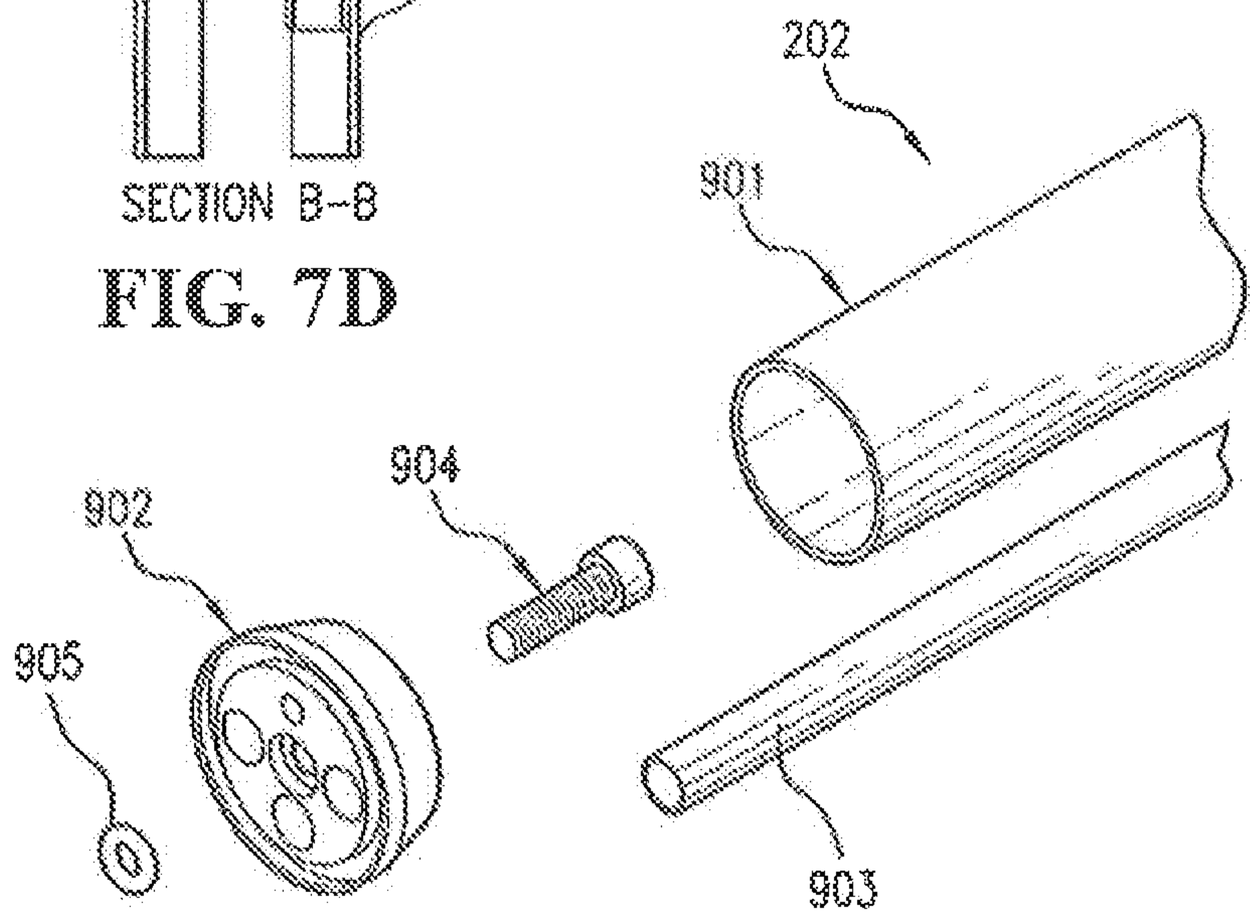

FIG. 7E

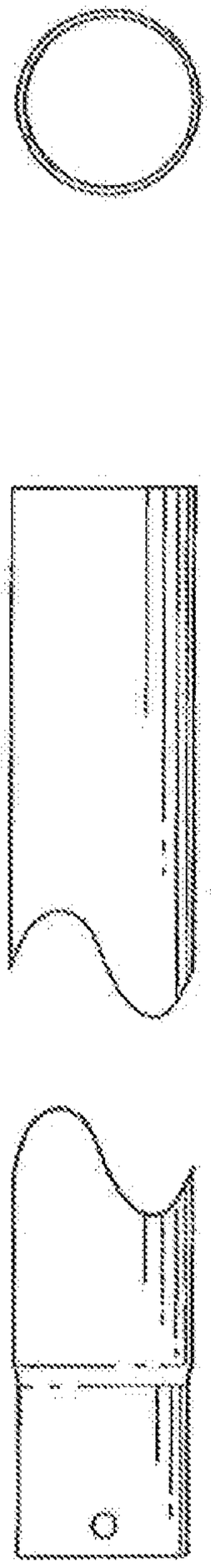

FIG. 8A

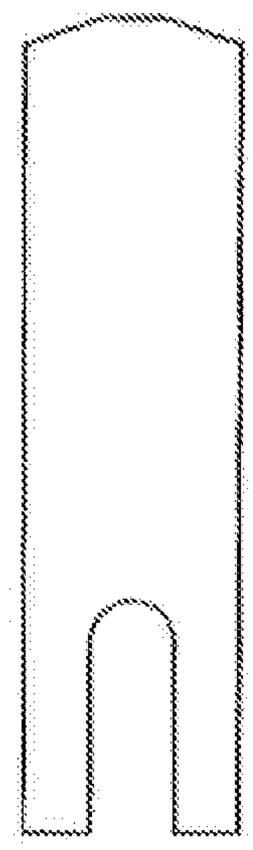

FIG. 8C

FIG. 8B

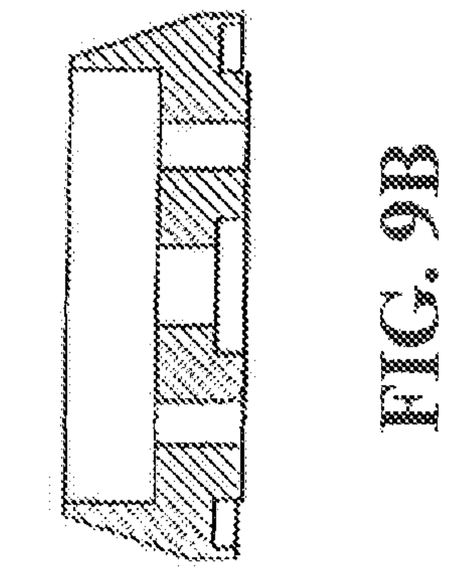

FIG. 9B

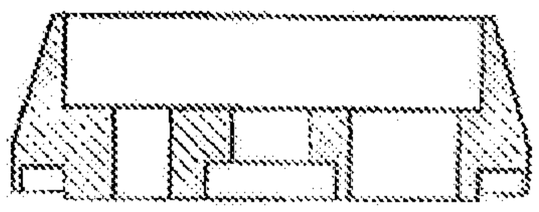

FIG. 9C

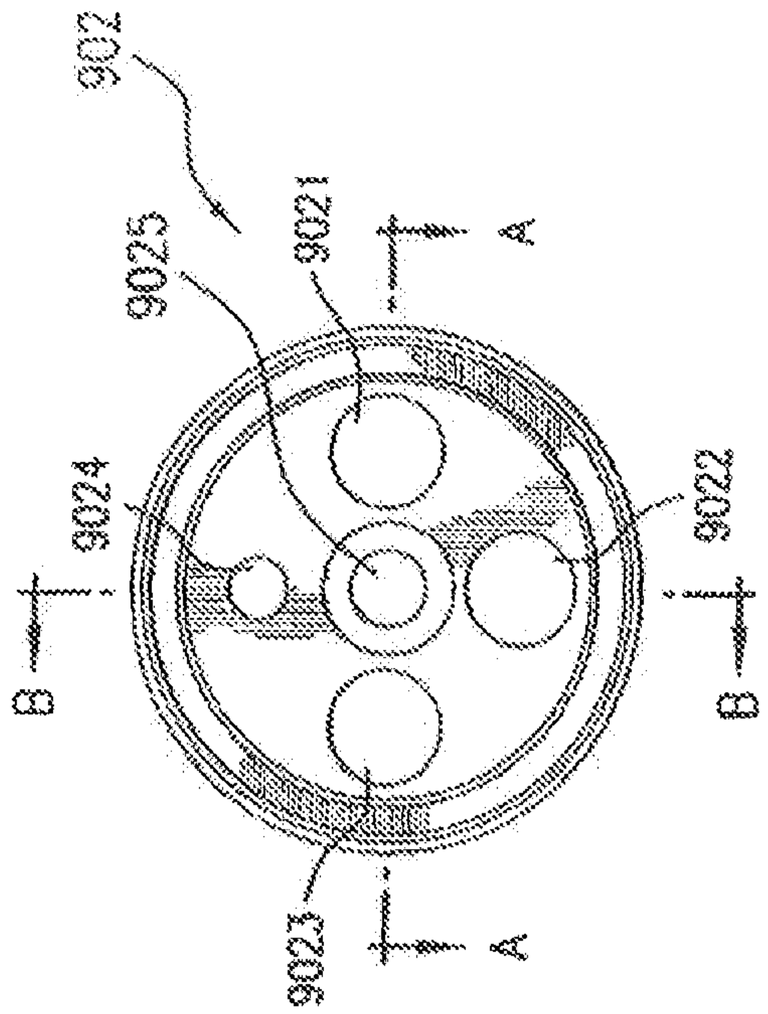

FIG. 9A

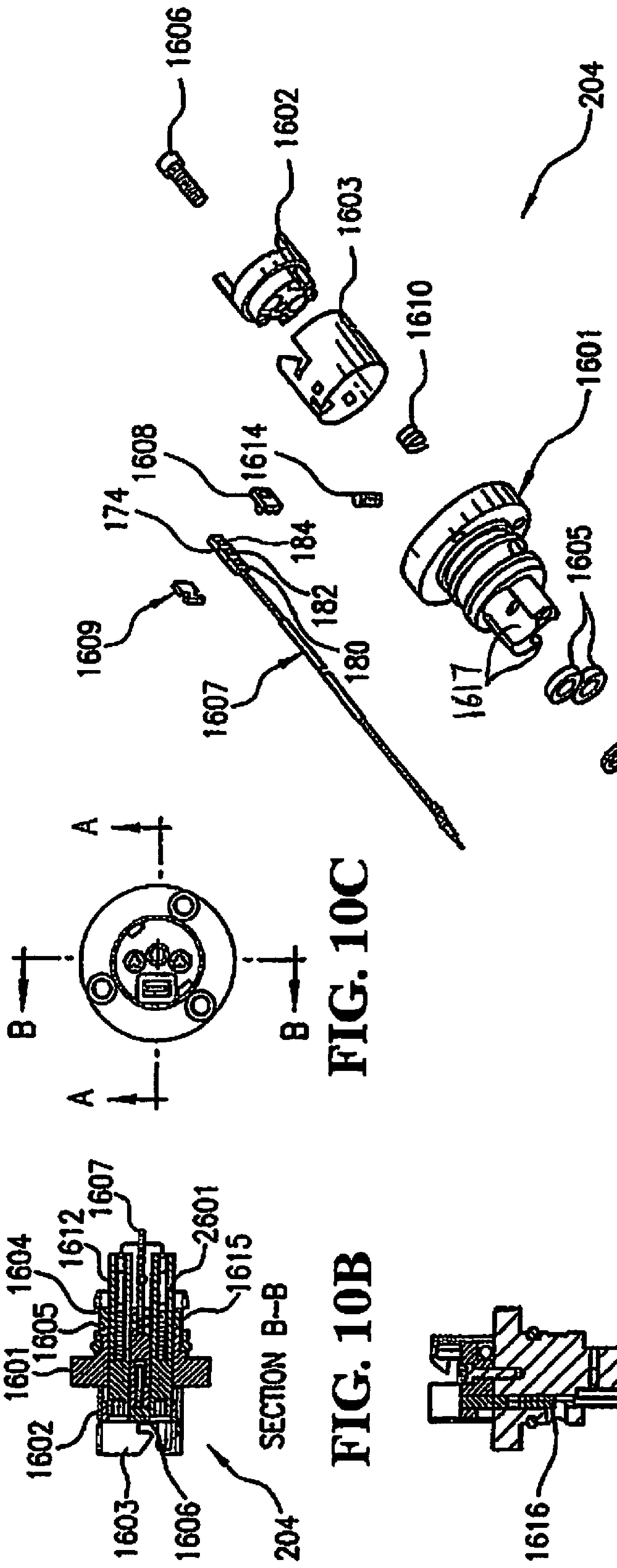

FIG. 10A

FIG. 10C

FIG. 10B

FIG. 10D

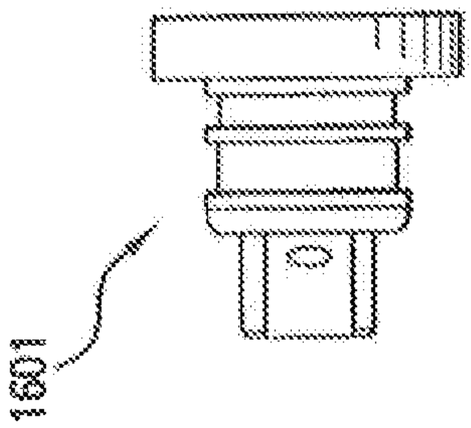

FIG. 11A

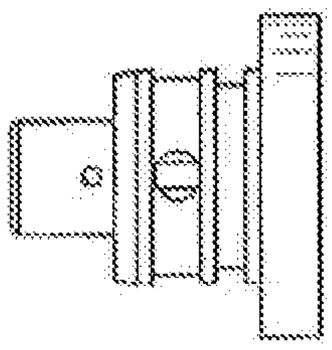

FIG. 11B

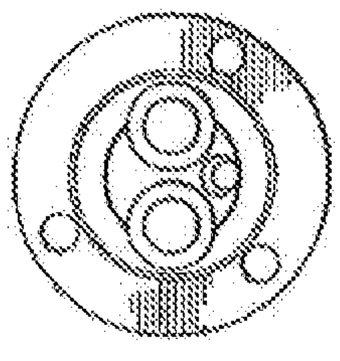

FIG. 11C

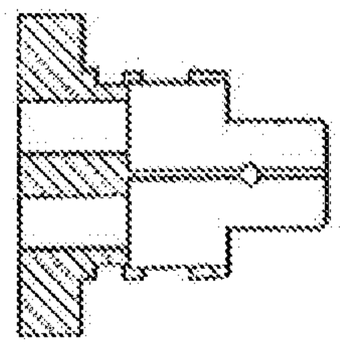

FIG. 11D

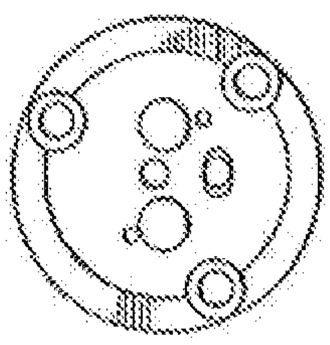

FIG. 11E

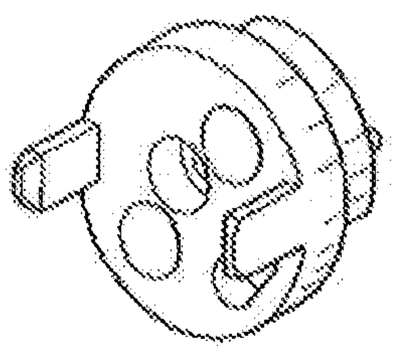

FIG. 12D

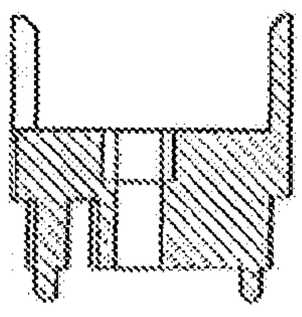

FIG. 12H

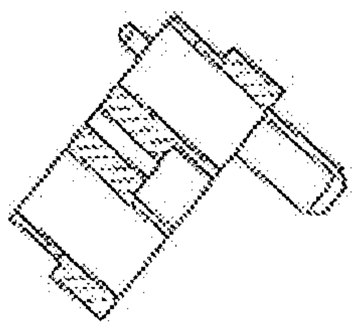

FIG. 12C

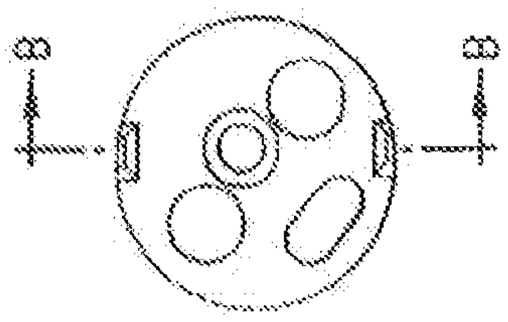

FIG. 12G

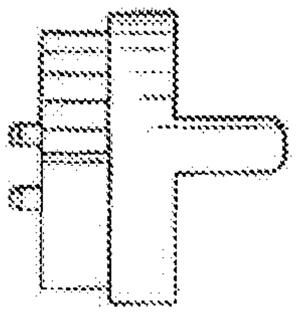

FIG. 12B

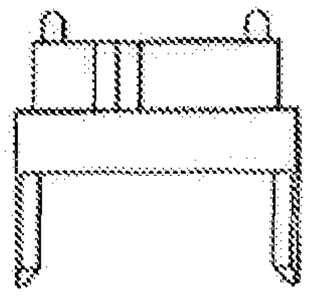

FIG. 12F

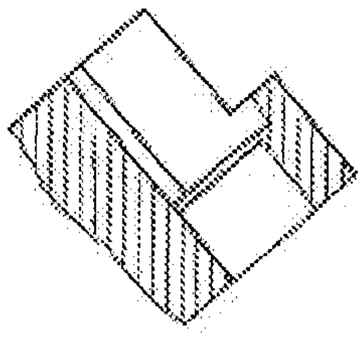

FIG. 12J

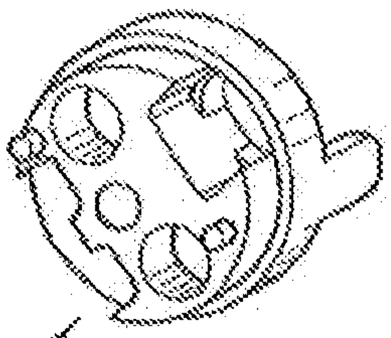

FIG. 12A

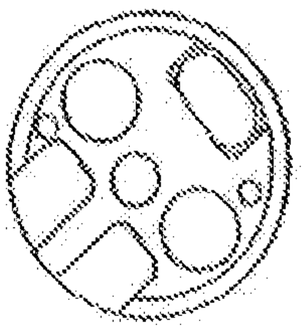

FIG. 12E

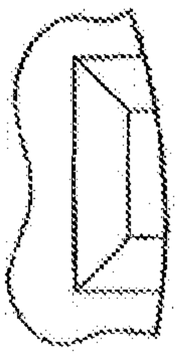

FIG. 12I

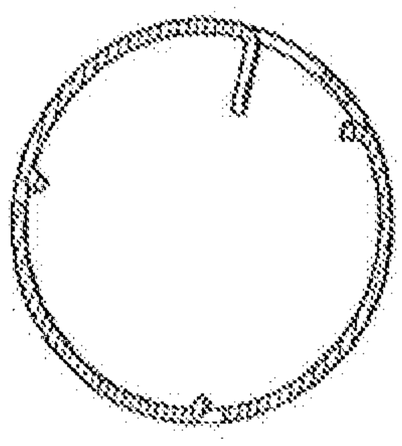

FIG. 13D

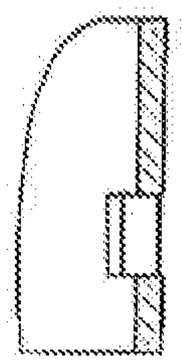

FIG. 13G

FIG. 13C

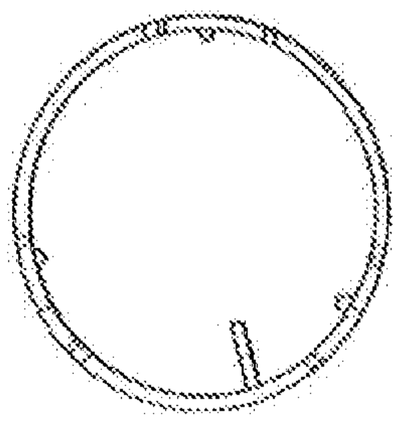

FIG. 13F

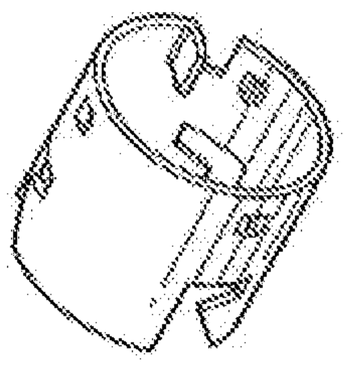

FIG. 13B

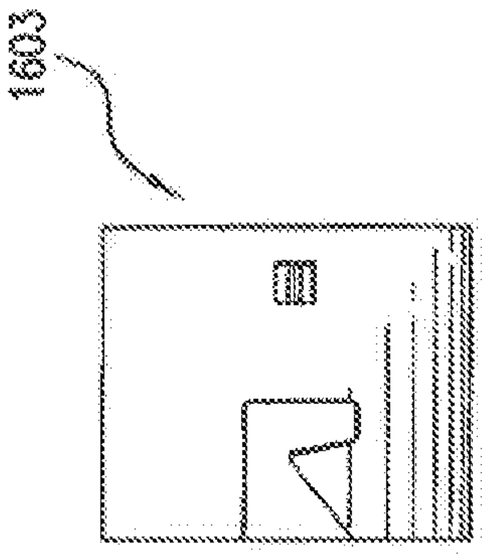

FIG. 13E

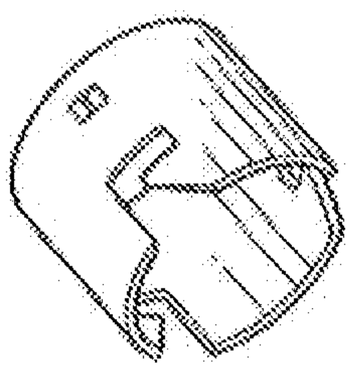

FIG. 13A

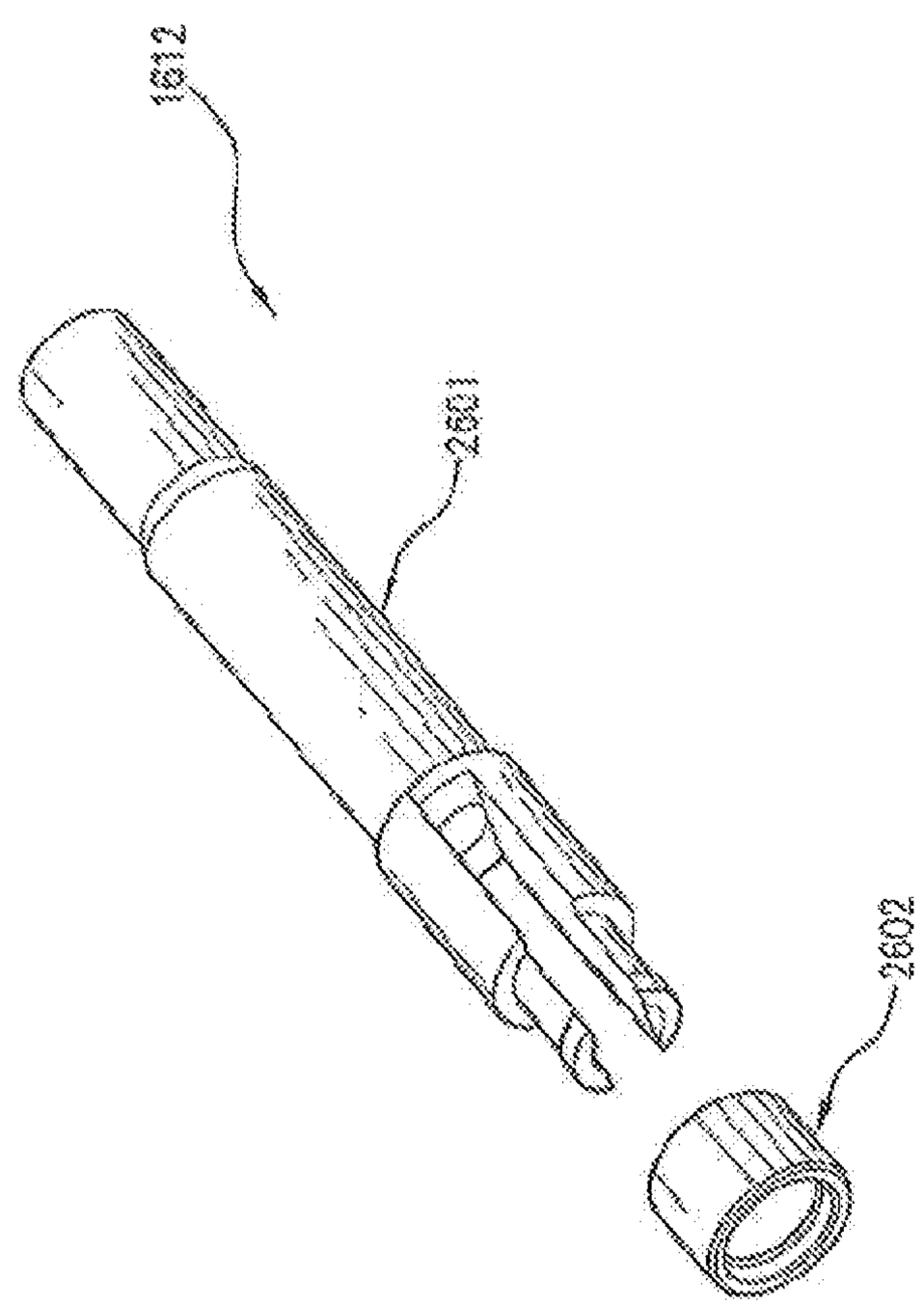

FIG. 14

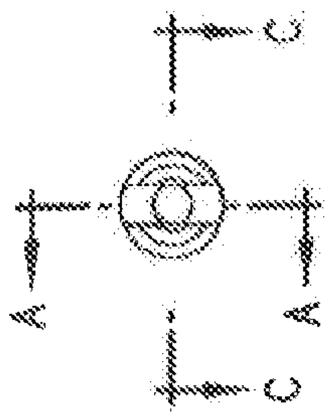

FIG. 15C

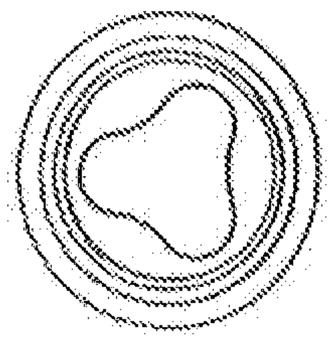

FIG. 15F

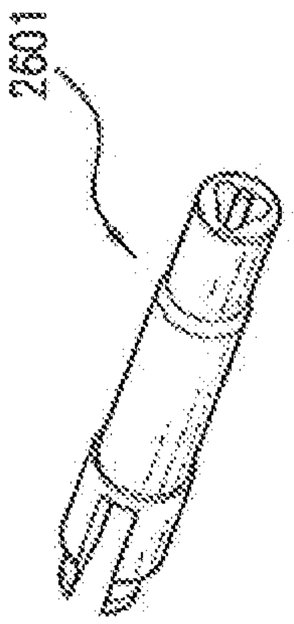

FIG. 15B

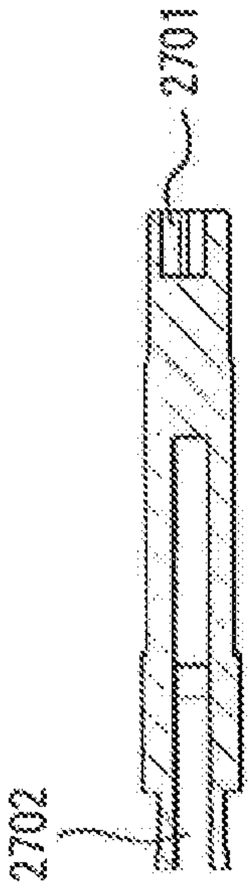

FIG. 15E

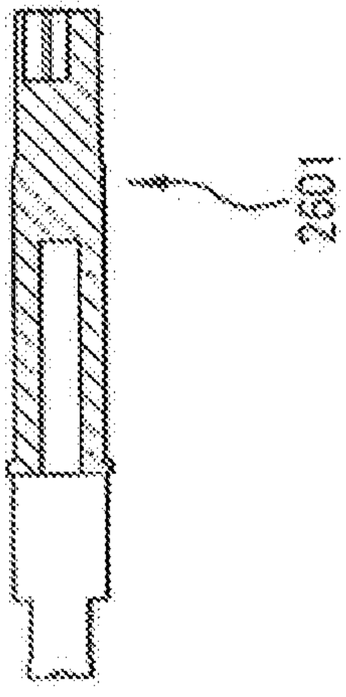

FIG. 15A

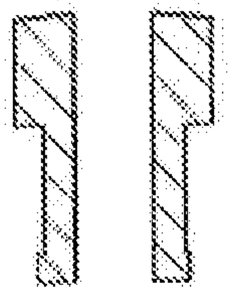

FIG. 15D

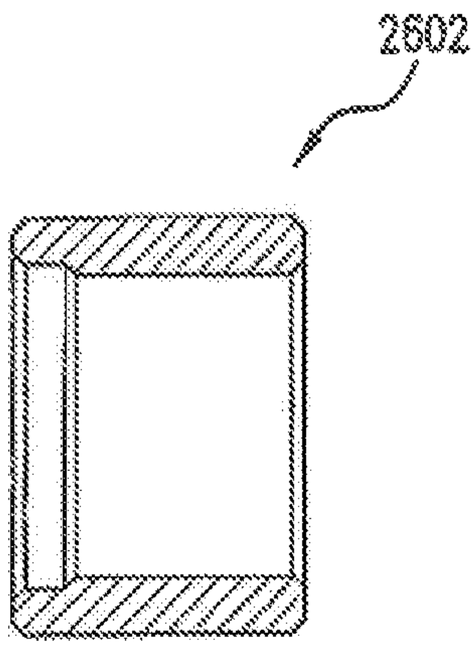

FIG. 16A

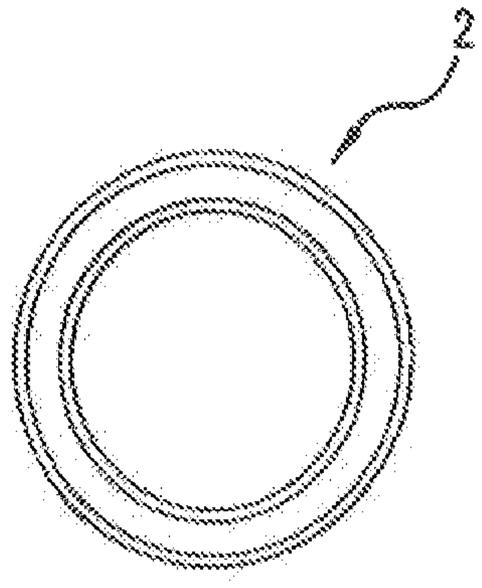

FIG. 16B

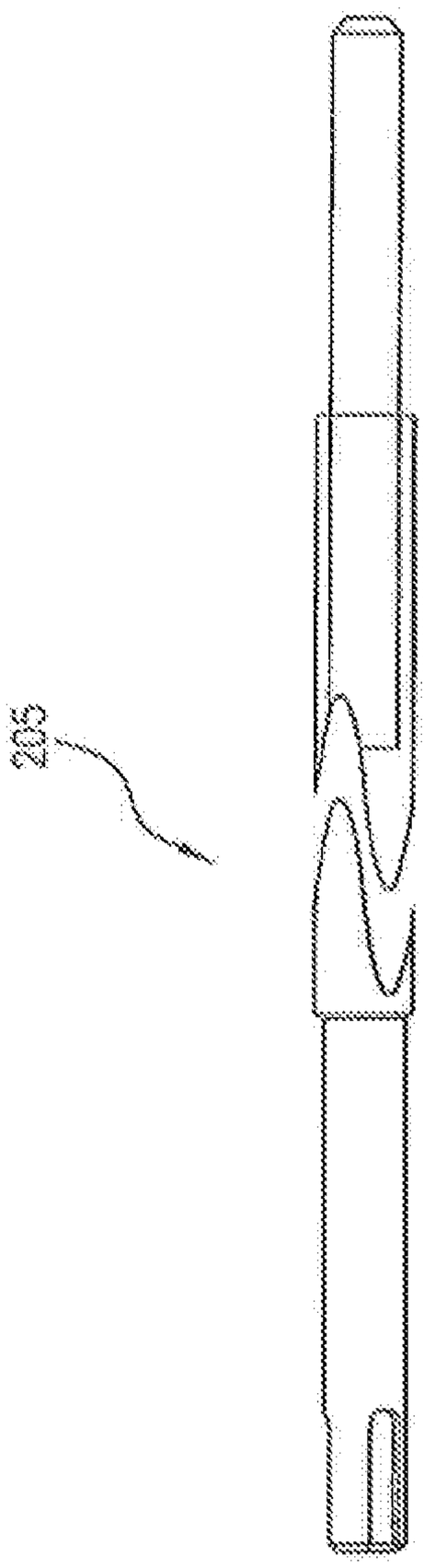

FIG. 17A

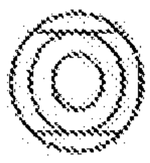

FIG. 17C

FIG. 17B

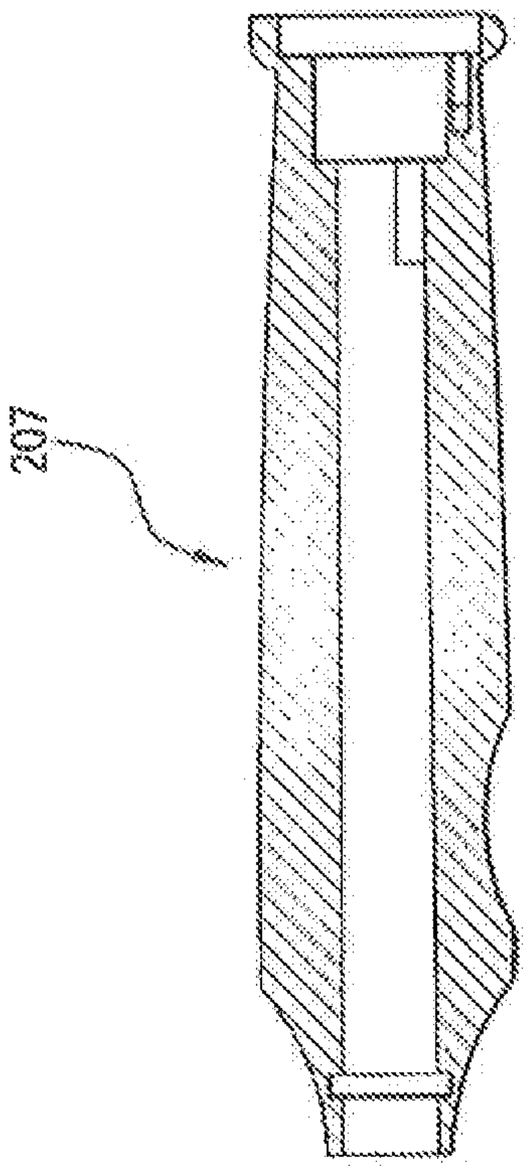

FIG. 18A

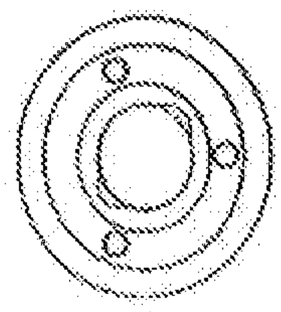

FIG. 18C

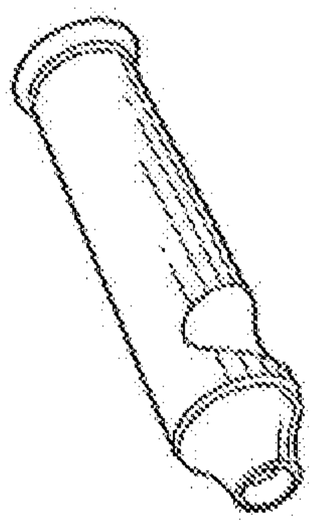

FIG. 18B

FLEXIBLE SHAFT EXTENDER AND METHOD OF USING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation of and claims the benefit of and priority to U.S. patent application Ser. No. 13/083,722, filed on Apr. 11, 2011, which is a Continuation of and claims the benefit of and priority to U.S. patent application Ser. No. 11/194,950, filed on Aug. 1, 2005 (now U.S. Pat. No. 7,947,034), which claims the benefit of and priority to U.S. Provisional Patent Application Ser. No. 60/592,778, entitled "Flexible Shaft Extender," filed on Jul. 30, 2004, each of which is expressly incorporated herein in its entirety by reference.

FIELD OF THE INVENTION

The present invention relates to a surgical device, and more particularly to a flexible shaft extender, and a method for using same.

BACKGROUND

Various surgical systems are known in which a surgical attachment is attached to a flexible shaft. In these systems, a surgical attachment may typically be manipulated and/or positioned within the patient's body by the user holding the flexible shaft at a location near to the surgical attachment. For surgical locations within the patient's body that are difficult to access, the user may be required to hold the flexible shaft at a substantial distance from its point of connection to the surgical attachment. However, the flexibility of the flexible shaft may hinder a user's ability to accurately position the surgical attachment within the body. This may be problematic when the position of the surgical attachment is well within the patient's body and the user is forced to hold the flexible shaft at a substantial distance from its point of connection to the surgical attachment. The resulting lack of accuracy in positioning and manipulating the surgical attachment may negatively impact the effectiveness of the surgical attachment in performing the surgical procedure.

SUMMARY

The present invention relates to an extender for a flexible shaft of an electro-mechanical surgical system. The flexible shaft extender is substantially rigid. The flexible shaft extender is configured to be coupled at one end to the flexible shaft of an electro-mechanical surgical system and to be coupled at its other end to a surgical attachment. Advantageously, the flexible shaft extender includes a pair of rotatable drive shafts that are configured to engage and be secured with rotatable drive shafts of the flexible shaft of the electro-mechanical surgical system. In this manner, rotation of the rotatable drive shafts of the flexible shaft by an electro-mechanical driver device may cause the drive shafts of the flexible shaft extender to rotate, thereby rotating the complementary connectors of the surgical attachment so as to operate the surgical attachment.

Furthermore, the flexible shaft extender may include a data wiring harness or data cable which is configured to attach to and communicate with the surgical attachment and the data cable of the flexible shaft. In this manner, data, such as usage data, operating data, etc. may be conveyed via the flexible shaft extender between the surgical attachment and the data cable of the flexible shaft.

The present invention provides, in an example embodiment, for a surgical attachment used in an electro-mechanical surgical system that is coupleable to an electro-mechanical driver device via a flexible shaft, a substantially rigid extender that includes: a proximal end configured to be detachably coupled to a distal end of the flexible shaft; a distal end configured to be detachably coupled to the surgical attachment; at least one rotatable drive shaft configured to engage and be secured with a respective rotatable drive shaft of the flexible shaft such that rotation of the respective rotatable drive shaft of the flexible shaft by the electro-mechanical driver device causes the at least one rotatable drive shaft of the extender to rotate, thereby rotating a complementary connector of the surgical attachment so as to operate the surgical attachment. The extender may be autoclavable. The extender may include a memory unit. The memory unit may be configured to store one or more of serial number data, an attachment type identifier data and a usage data. One or more of the serial number data and the ID data may be configured as read-only data. The serial number data may be data uniquely identifying the extender. The ID data may be data identifying the type of the extender. The usage data may represent a number of times the extender has been used. The extender may include a data cable configured to transfer data between the memory unit and the electro-mechanical driver device. The extender may also include a data cable configured to transfer data-between a memory unit located in the surgical attachment and the electro-mechanical driver device.

The present invention also provides, in an example embodiment, a method for performing a surgical procedure, the method comprising the steps of: detachably coupling a proximal end of an extender to a flexible shaft, the flexible shaft being coupled to an electro-mechanical driver device, the extender being substantially rigid; detachably coupling a distal end of the extender to a surgical attachment such that at least one rotatable drive shaft engages and is secured with a respective rotatable drive shaft of the flexible shaft; rotating the respective rotatable drive shaft of the flexible shaft by the electro-mechanical driver device so as to cause the at least one rotatable drive shaft of the extender to rotate; and rotating, by the at least one rotatable drive shaft of the extender, a complementary connector of the surgical attachment so as to operate the surgical attachment. The method may include the step of storing in a memory unit of the extender one or more of serial number data, an attachment type identifier data and a usage data. The method may include the step of configuring one or more of the serial number data and the ID data as read-only data. The serial number data may be data uniquely identifying the extender. The ID data may be data identifying the type of the extender. The usage data may represent a number of times the extender has been used. The method may include the step of transferring, via a data cable located within the extender, data between the memory unit and the electro-mechanical driver device. The method may include the step of storing in a memory unit of the surgical attachment one or more of serial number data, an attachment type identifier data and a usage data. The method may also include the step of transferring, via a data cable located within the extender, data between the memory unit and the electro-mechanical driver device.

Additional features of the flexible shaft extender of the present invention are discussed in greater detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A is a surgical system, according to an example embodiment of the present invention.

FIG. **1**B is a side view, partially in section, of a flexible shaft, according to an example embodiment of the present invention.

FIG. **1**C is a cross-sectional view of the flexible shaft taken along the line **1**C-**1**C shown in FIG. **1**B.

FIG. **1**D is a rear end view of a first coupling of the flexible shaft, according to an example embodiment of the present invention.

FIG. **1**E is a front end view of a second coupling of the flexible shaft, according to an example embodiment of the present invention.

FIG. **2** is an exploded perspective view of a flexible shaft extender, according to an example embodiment of the present invention.

FIGS. **3**A to **3**E illustrate various views of the distal tip assembly, according to an example embodiment of the present invention.

FIGS. **4**A to **4**D illustrate various views of the distal end tip, according to an example embodiment of the present invention.

FIGS. **5**A to **5**E illustrate various views of the DLU pin sealing element, according to an example embodiment of the present invention.

FIGS. **6**A to **6**C illustrate various views of the distal pin positioner, according to an example embodiment of the present invention.

FIGS. **7**A to **7**E illustrate various views of the tube assembly, according to an example embodiment of the present invention.

FIGS. **8**A to **8**C illustrate various views of the tube, according to an example embodiment of the present invention.

FIGS. **9**A to **9**C illustrate various views of the tube cap, according to an example embodiment of the present invention.

FIGS. **10**A to **10**D illustrate various views of the handle cap assembly, according to an example embodiment of the present invention.

FIGS. **11**A to **11**E illustrate various views of the handle cap, according to an example embodiment of the present invention.

FIGS. **12**A to **12**J illustrate various views of the keyplate, according to an example embodiment of the present invention.

FIGS. **13**A to **13**G illustrate various views of the quick connect collar, according to an example embodiment of the present invention.

FIG. **14** is an exploded view of the drive socket assembly, according to an example embodiment of the present invention.

FIGS. **15**A to **15**F illustrate various views of the drive socket spring, according to an example embodiment of the present invention.

FIGS. **16**A and **16**B illustrate various views of the drive socket sleeve, according to an example embodiment of the present invention.

FIGS. **17**A to **17**C illustrate various views of the drive shafts, according to an example embodiment of the present invention.

FIGS. **18**A to **18**C illustrate various views of the handle, according to an example embodiment of the present invention.

DETAILED DESCRIPTION

FIG. **1**A is a surgical system **100**, according to an example embodiment of the present invention. The surgical system **100** includes an electro-mechanical driver device **110** detachably coupled to a surgical attachment **120**. Such an electro-mechanical driver device is described in, for example, U.S. patent application Ser. No. 09/723,715, entitled "Electro-Mechanical Surgical Device," filed on Nov. 28, 2000, now issued as U.S. Pat. No. 6,793,652, U.S. patent application Ser. No. 09/836,781, entitled "Electro-Mechanical Surgical Device, filed on Apr. 17, 2001, now issued as U.S. Pat. No. 6,981,941, and U.S. patent application Ser. No. 09/887,789, entitled "Electro-Mechanical Surgical Device," filed on Jun. 22, 2001, now issued as U.S. Pat. No. 7,032,798, each of which is expressly incorporated herein in its entirety by reference. The electro-mechanical driver device **110** may include, for example, a remote power console (RPC) **105**, which includes a housing **115** having a front panel **125**. Mounted on the front panel **125** are a display device **130** and indicators **135***a*, **135***b*. A connection slot **140** is also provided on the front panel **125**. The electro-mechanical driver device **110** may also include a video display **145**, e.g., a television monitor, computer monitor, CRT or other viewing device, attached to the RPC **105**. The video display **145** may receive, for example, image signals (e.g., video signals) from an imaging device **195**. The electro-mechanical driver device **110** may also include a reception system **150** having a receiver or transceiver **155** and circuitry **160** operable to convert signals received from the imaging device **195** into a form suitable for display on the video display **145**. The reception system **150** may also include a memory device **165** for buffering and/or storing processed image data received from the imaging device **195**.

A flexible shaft **170** may extend from the housing **115** and may be detachably secured thereto via a first coupling **175**. The distal end **180** of the flexible shaft **170** may include a second coupling **185** adapted to detachably secure the surgical attachment **120** to the distal end **180** of the flexible shaft **170**.

Disposed within the interior channel of the flexible shaft **170**, and extending along the length thereof, may be rotatable shafts, steering cables, one or more data transfer cables and power transfer leads, all of which terminate at the second coupling **185** at the distal end **180** of the flexible shaft **170**. The electro-mechanical driver device **110** may include a motor system (not shown), which includes one or more motors configured to rotate the drive shafts and to apply tension or otherwise drive the steering cables to thereby steer the distal end **180** of the flexible shaft **170**.

Various types of surgical instruments or attachments **190** may be attached to the distal end **180** of the flexible shaft **170**. The surgical instrument or attachment may be, for example, a surgical stapler, a surgical cutter, a surgical stapler-cutter, a linear surgical stapler, a linear surgical stapler-cutter, a circular surgical stapler, a circular surgical stapler-cutter, a surgical clip applier, a surgical clip ligator, a surgical clamping device, a vessel expanding device, a lumen expanding device, a scalpel, a fluid delivery device or any other type of surgical instrument. Such surgical instruments are described, for example, in U.S. patent application Ser. No. 09/324,451, entitled "A Stapling Device for Use with an Electromechanical Driver Device for Use with Anastomosing, Stapling, and Resecting Instruments," now issued as U.S. Pat. No. 6,315,184, U.S. patent application Ser. No. 09/324,452, entitled "Electro-mechanical Driver Device for Use with Anastomosing, Stapling, and Resecting Instruments," now issued as U.S. Pat. No. 6,443,973, U.S. patent application Ser. No. 09/351,534, entitled "Automated Surgical Stapling System," now issued as U.S. Pat. No. 6,264,087, U.S. patent application Ser. No. 09/510,926, entitled "A Vessel and Lumen Expander Attachment for Use with an Electro-mechanical Driver

Device," now issued as U.S. Pat. No. 6,378,061, U.S. patent application Ser. No. 09/510,927, entitled "Electro-mechanical Driver and Remote Surgical Instruments Attachment Having Computer Assisted Control Capabilities," now issued as U.S. Pat. No. 6,716,233, U.S. patent application Ser. No. 09/510,931, entitled "A Tissue Stapling Attachment for Use with an Electro-mechanical Driver Device," now issued as U.S. Pat. No. 6,533,157, U.S. patent application Ser. No. 09/510,932, entitled "A Fluid Delivery Mechanism for Use with Anastomosing, Stapling, and Resecting Instruments," now issued as U.S. Pat. No. 6,491,201, and U.S. patent application Ser. No. 09/510,933, entitled "A Fluid Delivery Device for Use with Anastomosing, Stapling, and Resecting Instruments," now issued as U.S. Pat. No. 6,488,197, each of which is expressly incorporated herein in its entirety by reference thereto.

Referring to FIG. **1**B, there is seen a side view, partially in section, of the flexible shaft **170**. According to an example embodiment, the flexible shaft **170** includes a tubular sheath **28**, which may include a coating or other sealing arrangement to provide a fluid-tight seal between the interior channel **40** thereof and the environment. The sheath **28** may be formed of a tissue-compatible, sterilizable elastomeric material. The sheath **28** may also be formed of a material that is autoclavable. Disposed within the interior channel **40** of the flexible shaft **170**, and extending along the entire length thereof, may be a first rotatable drive shaft **30**, a second rotatable drive shaft **32**, a first steering cable **34**, a second steering cable **35**, a third steering cable **36**, a fourth steering cable **37** and a data transfer cable **38**. FIG. **1**C is a cross-sectional view of the flexible shaft **170** taken along the line **1**C-**1**C shown in FIG. **1**B and further illustrates the several cables **30**, **32**, **34**, **35**, **36**, **37**, **38**. Each distal end of the steering cables **34**, **35**, **36**, **37** is affixed to the distal end **180** of the flexible shaft **170**. Each of the several cables **30**, **32**, **34**, **35**, **36**, **37**, **38** may be contained within a respective sheath.

Referring now to FIG. **1**D, there is seen a rear end view of the first coupling **175**. The first coupling **175** includes a first connector **44**, a second connector **48**, a third connector **52** and a fourth connector **56**, each rotatably secured to the first coupling **175**. Each of the connectors **44**, **48**, **52**, **56** includes a respective recess **46**, **50**, **54**, **58**. As shown in FIG. **1**D, each recess **46**, **50**, **54**, **58** may be hexagonally shaped. It should be appreciated, however, that the recesses **46**, **50**, **54**, **58** may have any shape and configuration to non-rotatably couple and rigidly attach the connectors **44**, **48**, **52**, **56** to respective drive shafts of the motor arrangement contained within the housing **12**, as more fully described below. It should be appreciated that complementary projections may be provided on respective drive shafts of the motor arrangement to thereby drive the drive elements of the flexible shaft **170** as described below. It should also be appreciated that the recesses may be provided on the drive shafts and complementary projections may be provided on the connectors **44**, **48**, **52**, **56**. Any other coupling arrangement configured to non-rotatably and releasably couple the connectors **44**, **48**, **52**, **56** and the drive shafts of the motor arrangement may be provided.

One of the connectors **44**, **48**, **52**, **56** is non-rotatably secured to the first drive shaft **30**, and another one of the connectors **44**, **48**, **52**, **56** is non-rotatably secured to the second drive shaft **32**. The remaining two of the connectors **44**, **48**, **52**, **56** engage with transmission elements configured to apply tensile forces on the steering cables **34**, **35**, **36**, **37** to thereby steer the distal end **180** of the flexible shaft **170**. The data transfer cable **38** is electrically and logically connected with the data connector **60**. The data connector **60** includes, for example, electrical contacts **62**, corresponding to and equal in number to the number of individual wires contained in the data cable **38**. The first coupling **175** includes a key structure **42** to properly orient the first coupling **175** to a mating and complementary coupling arrangement disposed on the housing **115**. Such key structure **42** may be provided on either one, or both, of the first coupling **175** and the mating and complementary coupling arrangement disposed on the housing **115**. The first coupling **175** may include a quick-connect type connector, which may use, for example, a simple pushing motion to engage the first coupling **175** to the housing **115**. Seals may be provided in conjunction with any of the several connectors **44**, **48**, **52**, **56**, **60** to provide a fluid-tight seal between the interior of the first coupling **175** and the environment.

Referring now to FIG. **1**E, there is seen a front end view of the second coupling **185** of the flexible shaft **170**. The second coupling **185** includes a first connector **66** and a second connector **68**, each being rotatably secured to the second coupling **185** and each being non-rotatably secured to a distal end of a respective one of the first and second drive shafts **30**, **32**. A quick-connect type fitting **64** is provided on the second coupling **185** for detachably securing the surgical instrument or attachment thereto. The quick-connect type fitting **64** may be, for example, a rotary quick-connect type fitting, a bayonet type fitting, etc. A key structure **74** is provided on the second coupling **185** for properly aligning the surgical instrument or attachment to the second coupling **185**. The key structure or other arrangement for properly aligning the surgical instrument or attachment to the flexible shaft **170** may be provided on either one, or both, of the second coupling **185** and the surgical instrument or attachment. In addition, the quick-connect type fitting may be provided on the surgical instrument or attachment. A data connector **70**, having electrical contacts **72**, is also provided in the second coupling **185**. Like the data connector **60** of the first coupling **175**, the data connector **70** of the second coupling **185** includes the contacts **72** electrically and logically connected to the respective wires of the data transfer cable **38** and the contacts **62** of the data connector **60**. Seals may be provided in conjunction with the connectors **66**, **68**, **70** to provide a fluid-tight seal between the interior of the second coupling **185** and the environment.

Disposed within the housing **115** of the remote power console **105** are electro-mechanical driver elements configured to drive the drive shafts **30**, **32** and the steering cables **34**, **35**, **36**, **37** to thereby operate the electro-mechanical surgical device **10** and the surgical instrument or attachment attached to the second coupling **185**. Electric motors, each operating via a power source, may be disposed in the remote power console **105**. Any appropriate number of motors may be provided, and the motors may operate via battery power, line current, a DC power supply, an electronically controlled DC power supply, etc. It should also be appreciated that the motors may be connected to a DC power supply, which is in turn connected to line current and which supplies the operating current to the motors.

FIG. **2** is an exploded perspective view of a flexible shaft extender **10**, according to an example embodiment of the present invention. The flexible shaft extender **10** provides a substantially rigid handle that attaches to the second coupling **185** at the distal end **180** of the flexible shaft **170**. The flexible shaft extender **10** includes a distal tip assembly **201**, a tube assembly **202**, a distal end O-ring **203**, a handle cap assembly **204**, a pair of drive shafts **205**, a retention pin **206**, a handle **207**, a handle screw **208**, a handle O-ring **209**, a pair of tubes (e.g., of teflon) **210**, a bearing block **211** and a pin block **212**.

FIGS. **3**A to **3**E illustrate various views of the distal tip assembly **201**. As shown in FIG. **3**A, the distal tip assembly

201 includes a distal end tip **301**, a pair of bearings **302**, a pair of sealing elements **303**, a distal pin positioner **304**, a DLU pin sealing element **305** and a dowel pin **306**. The distal tip assembly **201** is configured to have a surgical attachment attached thereto. When the flexible shaft extender **10** is assembled, the distal tip assembly **201** is attached to the distal end of the tube assembly **202**.

FIGS. **4**A to **4**D illustrate various views of the distal end tip **301**. The distal end tip **301** includes two stepped bores **3011** and **3012**. In addition, the distal end tip **301** includes a centrally-located threaded bore **3013**. In addition, the distal end tip **301** includes a rectangular longitudinal opening **3014**.

FIGS. **5**A to **5**E illustrate various views of the DLU pin sealing element **305**. FIGS. **6**A to **6**C illustrate various views of the distal pin positioner **304**.

Referring back to FIGS. **3**B and **3**D, there is shown the various components of the distal tip assembly **201** in the assembled condition. As shown in FIG. **3**B, the pair of bearings **302** are inserted within the two stepped bores **3011** and **3012** of the distal end tip **301**. As shown in FIGS. **3**D and **3**E, the distal pin positioner **304** is inserted into the distal end tip **301** and fits within the rectangular longitudinal opening **3014** and is flush with the distal-most surface of the distal end tip. The DLU pin sealing element **305** maintains the distal pin positioner **304** within the rectangular longitudinal opening **3014** of the distal end tip **301**.

FIGS. **7**A to **7**E illustrate various views of the tube assembly **202**. For instance, FIG. **7**E is an exploded view of the tube assembly **202**. The tube assembly **202** includes a tube **901**, a tube cap **902**, a wire retention tube **903**, a screw **904** and a distal end O-ring **905**.

FIGS. **8**A to **8**C illustrate various views of the tube **901**. FIGS. **9**A to **9**C illustrate various views of the tube cap **902**. The tube cap **902** may include first second, third and fourth orifices **9021**, **9022**, **9023** and **9024** and a central orifice **9025**.

Referring back to FIG. **7**D, there is shown the various components of the tube assembly **202** in the assembled condition. As shown in FIG. **7**D, the tube **901** may be welded to the tube cap **902**. The wire retention tube **903** is arranged longitudinally within the tube **901** and may be welded to the tube cap **902** so as to be longitudinally aligned with the orifice **9022** of the tube cap **902**. The screw **904** is inserted through the central orifice **9025** of the tube cap. The distal end O-ring **905** is retained around the screw **904** in a distal recess of the tube cap **902**.

FIGS. **10**A to **10**D illustrate various views of the handle cap assembly **204**. FIG. **10**A is an exploded view of the handle cap assembly **204**. The handle cap assembly **204** includes a handle cap **1601**, a keyplate **1602**, a quick connect collar **1603**, a pair of bearings **1604**, a pair of proximal sealing elements **1605**, a screw **1606**, a wiring harness assembly **1607**, an outboard shim **1608**, an inboard shim **1609**, a spring **1610**, a handle O-ring **1611**, a drive socket assembly **1612**, a drive socket spring **1613**, a quick connect spring **1614**, a bearing spacer **1615** and potting **1616**.

The wiring harness assembly **1607** includes at its proximal end a device having a connector (e.g., for connection to the data transfer cable **38** of the flexible shaft **170**), a memory unit **174** that may store various types of data, and one or more wires or cables extending distally therefrom. An exemplary memory unit **174** is described in, for example, U.S. patent application Ser. No. 09/723,715, entitled "Electro-Mechanical Surgical Device," filed on Nov. 28, 2000, now issued as U.S. Pat. No. 6,793,652, U.S. patent application Ser. No. 09/836,781, entitled "Electro-Mechanical Surgical Device, filed on Apr. 17, 2001, now issued as U.S. Pat. No. 6,981,941, and U.S. patent application Ser. No. 09/887,789, entitled "Electro-Mechanical Surgical Device," filed on Jun. 22, 2001, now issued as U.S. Pat. No. 7,032,798, each of which, as stated above, is expressly incorporated herein in its entirety by reference. For instance, the memory unit **174** may store, for instance, serial number data **180**, an attachment type identifier data **182** and a usage data **184**. Memory unit **174** may additionally store other data. Both the serial number data **180** and the ID data **182** may be configured as read-only data. In the example embodiment, serial number data **180** is data uniquely identifying the particular flexible shaft extender, whereas the ID data **182** is data identifying the type of the flexible shaft extender, such as, for example, a flexible shaft extender of a given length. The usage data **184** represents usage of the particular flexible shaft extender, such as, for example, the number of times the flexible shaft extender has been used.

It should be appreciated that the flexible shaft extender **10** may be designed and configured to be used a single time or multiple times. Accordingly, the usage data **184** may be used to determine whether the flexible shaft extender **10** has been used and whether the number of uses has exceeded the maximum number of permitted uses. An attempt to use the flexible shaft extender **10** after the maximum number of permitted uses has been reached may generate an ERROR condition.

FIGS. **11**A to **11**E illustrate various views of the handle cap **1601**. FIGS. **12**A to **12**J illustrate various views of the keyplate **1602**. FIGS. **13**A to **13**G illustrate various views of the quick connect collar **1603**.

FIG. **14** is an exploded view of the drive socket assembly **1612**. The drive socket assembly **1612** includes a drive socket **2601** and a drive socket sleeve **2602**. FIGS. **15**A to **15**F illustrate various views of the drive socket spring **2601**. The drive socket spring **2601** has a longitudinal slit **2702** at its distal end and a centrally-disposed, longitudinally-arranged bore **2701**. FIGS. **16**A and **16**B illustrate various views of the drive socket sleeve **2602**.

Referring back to FIG. **10**B, there is shown the various components of the handle cap assembly **204** in the assembled condition. As shown in FIG. **10**B, the keyplate **1602** is mounted to the proximal surface of the handle cap **1601** by the screw **1606**. The quick connect collar **1603** is retained against the proximal surface of the handle cap **1601** by being in locked engagement between the keyplate **1602** and the handle cap **1601**. The quick connect collar **1603** is configured to be detachably coupled to the second coupling **185** at the distal end **180** of the flexible shaft **170**. The pair of bearings **1604** fit within corresponding orifices **1617** of the handle cap **1601**. The pair of orifices **1617** of handle cap **1601** are configured to engage and rotatably secure to a corresponding one of the first rotatable drive shaft **30** and the second rotatable drive shaft **32** of the electro-mechanical driver device **110**. In particular, one each of the bearing spacers **1615**, the proximal sealing elements **1605** and the bearings **1604** are mounted on a respective drive socket **2601**, and operate to rotatably retain the drive socket **2601** within respective orifices **1617** of the handle cap **1601** and, in turn, the drive sockets **2601** non-rotatably retain corresponding rotatable drive shafts **30**, **32** of the electro-mechanical driver device **110**. The wiring harness **1607** is retained within the handle cap assembly **204** such that a proximal end is accessible via an opening in the keyplate **1602**, and a distal end extends to the distal end of the tube assembly **202** and out of an orifice of the distal tip assembly **201**. In this manner, data may be conveyed via the wiring harness **1607** from a surgical attachment attached to the distal tip assembly **201** to the data transfer cable **38** within the flexible shaft **170**.

FIGS. **17**A to **17**C illustrate various views of the drive shafts **205**. In the example embodiments discussed and illustrated herein, the flexible shaft extender **10** includes two drive shafts **205**, though any number, e.g., one or more, drive shafts may be employed. The drive shafts **205** are rotatable within the flexible shaft extender **10** so as to rotate a respective component of the surgical attachment. The proximal ends of the drive shafts **205** are insertable within and rotatably secured within the bore **2701** of the drive socket **2601**.

FIGS. **18**A to **18**C illustrate various views of the handle **207**. When the flexible shaft extender **10** is assembled, the rotatable drive shafts **205** are positioned within the tubes **210**, which may be made of a material, e.g., teflon, that minimizes the friction between the rotatable drive shafts **205** and the tubes **210**.

In use, the quick connect collar **1603** is attached to the second coupling **185** at the distal end **180** of the flexible shaft **170**. In this manner, the first connector **66** and the second connector **68** of the second coupling **185**, that engage and are rotatably secured with first and second rotatable drive shafts **30** and **32**, may also engage and be rotatably secured with the drive socket assembly **1612**, which in turn engages and is rotatably secured with the proximal ends of the drive shafts **205**.

In addition, a surgical attachment **190** may be attached to the distal tip assembly **201**. In this manner, the distal ends of the drive shafts **205** may engage and be rotatably secured with complementary connectors of the surgical attachment **190**. Rotation of the first and second rotatable drive shafts **30** and **32** of the flexible shaft **170** by the electro-mechanical driver device **110** cause the drive shafts **205** of the flexible shaft extender **10** to rotate, which thereby rotate the complementary connectors of the surgical attachment **190** so as to operate the surgical attachment **190**. Furthermore, data, such as usage data, operating data, etc. may be conveyed between the surgical attachment **190** and the data transfer cable **38** of the flexible shaft **170**, and from the memory unit **174** of the flexible shaft extender **10** to the data transfer cable **38** of the flexible shaft **170**.

The flexible shaft extender **10** provides a substantially rigid device that may be inserted by a user into a surgical site. The flexible shaft extender **10** may provide a user with improved control of the surgical attachment **190**, as compared to the use of, e.g., a surgical attachment **190**, that is attached directly to, e.g., the flexible shaft **170**. For instance, when a surgical attachment is attached to a conventional flexible shaft, the surgical attachment is typically manipulated and/or positioned within the patient's body by the user holding the flexible shaft at a location near to the surgical attachment. For surgical locations within the patient's body that are difficult to access, the user may be required to hold the flexible shaft at a substantial distance from its point of connection to the surgical attachment. However, the flexibility of the flexible shaft may hinder a user's ability to accurately position the surgical attachment within the body. This may be problematic when the position of the surgical attachment is well within the patient's body and the user is forced to hold the flexible shaft at a substantial distance from its point of connection to the surgical attachment. The resulting lack of accuracy in positioning and manipulating the surgical attachment may negatively impact the effectiveness of the surgical attachment in performing the surgical procedure. However, the present invention according to various embodiments thereof, provides a substantially rigid extender between the surgical attachment and the flexible shaft. In this manner, a surgical attachment may be manipulated and/or positioned within the patient's body by the user holding the extender. Thus, for any surgical locations within a patient's body, and particularly for those surgical locations that are difficult to access, the user may hold the extender at a substantial distance from its point of connection to the surgical attachment without the flexibility of the flexible shaft hindering the user's ability to accurately position the surgical attachment within the body. Even when the position of the surgical attachment is well within the patient's body and the user is forced to hold the extender at a substantial distance from its point of connection to the surgical attachment, the substantially rigid extender may enable improved control by the user of the surgical attachment when positioning or manipulating same. The resulting improvement of accuracy in positioning and manipulating the surgical attachment may improve the effectiveness of the surgical attachment in performing the surgical procedure.

Furthermore, the flexible shaft extender **10** may be autoclavable by virtue of the material with which it is constructed, as well as the sealing components that prevent moisture from entering the flexible shaft extender **10**. When autoclavable, the flexible shaft extender may be re-used, e.g., for different patients, different types of surgical procedures and/or with different surgical attachments, thereby providing a significant cost savings relative to single-use devices.

Thus, the several aforementioned objects and advantages of the present invention are most effectively attained. Those skilled in the art will appreciate that numerous modifications of the exemplary embodiment described hereinabove may be made without departing from the spirit and scope of the invention. Although various exemplary embodiments of the present invention has been described and disclosed in detail herein, it should be understood that this invention is in no sense limited thereby.

What is claimed is:

1. An electro-mechanical surgical system, comprising:

an electro-mechanical driver device including a flexible shaft including a pair of rotatable drive members extending along a length thereof; and

an extender having:

a proximal end including a handle having a handle cap assembly configured to detachably couple to a distal end of the flexible shaft, the handle cap assembly including:

a handle cap including at least two orifices;

a key plate; and

a quick connect collar mounted to a proximal end of the handle cap and retained thereagainst by the key plate; and

a distal end configured to be detachably coupled to a proximal end of a surgical attachment,

wherein each orifice of the at least two orifices is configured to engage and rotatably secure to a corresponding one of the pair of rotatable drive members of the electro-mechanical driver device such that rotation of the pair of rotatable drive members causes at least two rotatable shafts of the extender to rotate thereby transmitting a force to the surgical attachment so as to operate the surgical attachment.

2. The electro-mechanical surgical system of claim **1**, wherein the handle cap has at least one aperture at the proximal end thereof.

3. The electro-mechanical surgical system of claim **2**, wherein a distal end of the key plate seats within the at least one aperture at the proximal end of the handle cap.

4. The electro-mechanical surgical system of claim **1**, wherein the quick connect collar is configured to facilitate coupling and uncoupling the extender to the distal end of the flexible shaft.

5. The electro-mechanical surgical system of claim 1, wherein the key plate includes a corresponding pair of orifices that align with the at least two orifices of the handle cap.

6. The electro-mechanical surgical system of claim 1, further comprising a pair of drive sockets, each drive socket of the pair of drive sockets being rotatably retained within a corresponding one of the at least two orifices of the handle cap.

7. The electro-mechanical surgical system of claim 6, wherein each drive socket of the pair of drive sockets have mounted thereon:

a bearing spacer,

a sealing element and

a bearing, wherein the bearing spacer, the sealing element, and the bearing are configured to rotatably retain each drive socket of the pair of drive sockets in the corresponding one of the at least two orifices of the handle cap.

8. The electro-mechanical surgical system of claim 7, wherein the sealing element of each drive socket of the pair of drive sockets and seal elements provided at the distal end of the extender prevent moisture from entering the extender to allow sterilization of the extender via an autoclave.

9. The electro-mechanical surgical system of claim 1, wherein the key plate includes at least one aperture defined therethrough that is configured to provide access for a wiring harness retained within the handle cap assembly.

10. The electro-mechanical surgical system of claim 9, wherein a proximal end of the wiring harness is accessible through the at least one aperture defined through the key plate and includes a connector for connection to a data transfer cable of the flexible shaft.

11. The electro-mechanical surgical system of claim 10, wherein a distal end of the wiring harness extends out of the distal end of the extender for communicating data from the surgical attachment to the data transfer cable of the flexible shaft.

12. The electro-mechanical surgical system of claim 1, wherein the surgical attachment is a surgical stapler-cutter.

13. The electro-mechanical surgical system of claim 1, wherein the extender is flexible.

14. An electro-mechanical surgical system, comprising:

an electro-mechanical driver device including a pair of rotatable drive members projecting from a distal end thereof;

an extender having:

a proximal end including a handle having a handle cap assembly configured to detachably couple to the distal end of the electro-mechanical driver device, the handle cap assembly including:

at least two orifices, each orifice of the at least two orifices configured to engage and rotatably secure to a corresponding one of the pair of rotatable drive members of the electro-mechanical driver device; and

a pair of drive sockets, wherein each drive socket of the pair of drive sockets is rotatably retained within a corresponding one of the at least two orifices of the handle cap assembly, each drive socket of the pair of drive sockets having mounted thereon:

a bearing spacer;

a sealing element; and

a bearing, wherein the bearing spacer, the sealing element, and the bearing are configured to rotatably retain each drive socket of the pair of drive sockets in the corresponding one of the at least two orifices; and

a distal end configured to be detachably coupled to a proximal end of a surgical attachment, wherein a rotation of either of the pair of rotatable drive members causes a corresponding one of a pair of rotatable shafts of the extender to rotate thereby transmitting a force to the surgical attachment so as to operate the surgical attachment.

15. The electro-mechanical surgical system of claim 14, wherein the pair of shafts of the extender are rotatable shafts.

16. The electro-mechanical surgical system of claim 14, wherein the sealing element of each drive socket of the pair of drive sockets and seal elements provided at the distal end of the extender prevent moisture from entering the extender to allow sterilization of the extender via an autoclave.

17. The electro-mechanical surgical system of claim 14, wherein the surgical attachment is a surgical stapler-cutter.

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